THE GLASS INDUSTRY

VOLUME 34, NUMBER 3, MARCH, 1953

KINETICS OF THE BLEACHING OF GLASSES COLORED BY IRRADIATION IN THE CHATILLON PILE

By GUY MAYER and JULES GUERON

TRANSLATED BY DR. N. J. KREIDL

Editor's Note: While the work of the eminent scientists Guy Mayer and Jules Gueron of the French Atomic Energy Commission was conducted independently of other research on coloration of glass by radiation, the following translation could in a manner be considered a fourth part to the series "Coloration of Glass by Radiation" by Kuan-Han Sun and Norbert J. Kreidl. This series appeared in the October, November, and December 1952 issues of THE GLASS INDUSTRY.

Abstract

Samples of glass and silica were colored by irradiation in the Chatillon pile. The absorption spectra of the irradiated samples were studied between 200 and 2000 mμ.

From illumination and heating experiments, the resolution of their spectra into bands relative to centers of different species was attempted and the kinetics of the disappearance of the centers was studied.

With the aid of the theories on alkali halides, the interpretation of the numerical values obtained for absolute rates of reaction, for experimental activation energies and orders of reaction, was also attempted.

Introduction

Since the discovery of radium and its storage in glass containers, and since the fabrication of X-ray tubes from glass, the colorations produced by various radiations of great energy in glass and silica were observed frequently.[1] Analogous effects are produced by pile irradiation. These colorations disappear upon heating. This disappearance is the subject of the study of the present authors and this paper contains the first results of this study which is being continued.

Experimental Methods

The samples were heated in an oil bath, the temperature of which was held constant to ± 2°C. The absorption spectra were measured at ambient temperature by means of a Beckmann spectrophotometer with quartz optics usable between 200 and 2000 mμ.

Principal Errors: (a) The samples studied were not perfectly homogeneous. In the interior of a glass sample of 2 cm² surface and 2 mm thickness, the absorption coefficient varied by ± 2% depending upon the layers examined. For silica samples of analogous dimensions, this variation went up to ± 5%. The fluctuations are particularly important in the domain of short wavelengths. After every heating period it is impossible, in spite of every precaution, to place the sample into the same position in relation to the luminous beam of the photometer; and, although the Beckmann permits absorption measurements to almost 5°/00, the use made of the numbers obtained—i.e., the calculation of reaction speeds from paired measurements—prevents the attribution of an error below 1% in the case of glass, and 3% in the case of silica, to the results; (b) The time spent in the oil is evidently greater than that spent at the temperature of the oil. This error is about 5% in the case of heating at 100°C. for 30 min. It is greater for higher temperatures and shorter holds. For reasonable precision, longer experiments often extending to several days were made.

Chemical Kinetics

(a) The absorption is due to only one species of color centers. The absorption coefficient a_λ is proportional to the number (n) of centers per cm³:

$$a_\lambda = C_\lambda n \qquad (1)$$

C_λ is a constant depending upon the wavelength, λ, only. Also:

$$da_\lambda/dt = C_\lambda \, dn/dt \qquad (2)$$

The experimental energy of activation W is obtained independently of any hypothesis on the order or reaction by comparing the times (t) necessary to reduce the absorption from the same initial value to the same final value at various temperatures:

$$t_1 \exp(-W/\underline{k}T_1) = t_2 \exp(-W/\underline{k}T_2) = \ldots \quad (3)^*$$

In order to determine the order of reaction one plots log a as a function of time (t), and $1/a$ as a function of time (t). The first or second of these curves becomes a straight line depending upon whether the reaction is of the first or second order. From the slope of this straight line one derives the coefficient k which appears in the kinetic

---

Translated from *Journal de Chimie Physique et de Physico-Chimie Biologique 49*, April 1952, pg. 204-12.

* k Boltzman const. } are distinguished throughout the paper by underlining.
k̄ Reaction const. }

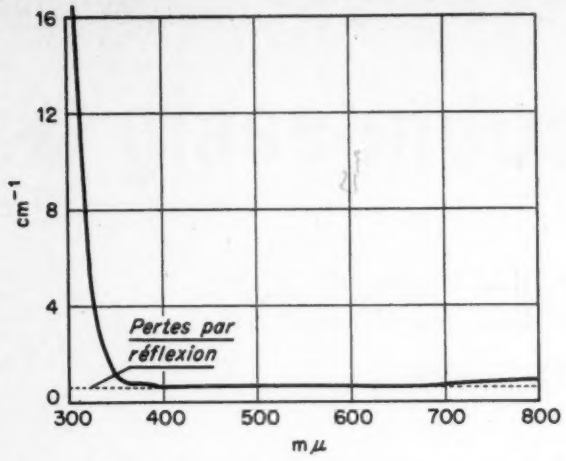


Fig. 1. Absorption (cm^{-1}) of glass before irradiation. (dotted line: reflection loss)

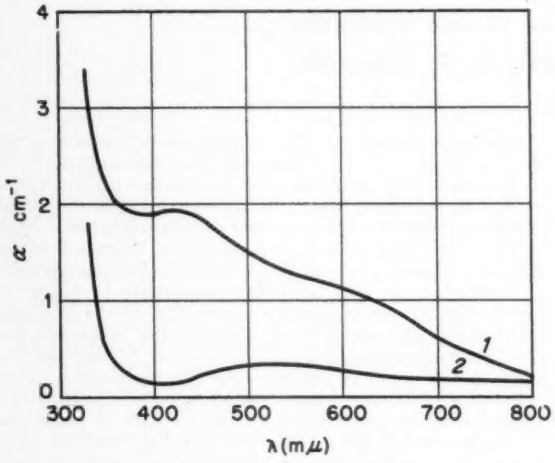


Fig. 2. Curve 1: Supplementary absorption (cm^{-1}) after 300 hrs. pile irradiation. Curve 2: what is left of this absorption after 20 hrs. at 125°C.

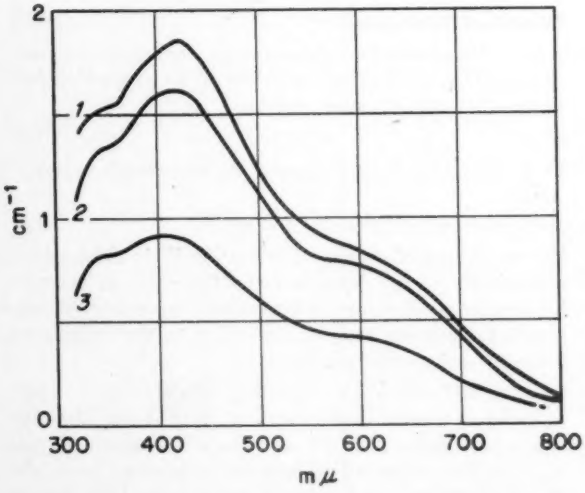


Fig. 3. Absorption lost in 2 hrs. at 102°C. (Curve 1); in 10 min. at 123°C. (Curve 2); in 3 hrs. at 80°C. (Curve 3). The three samples did not have the same initial absorption.

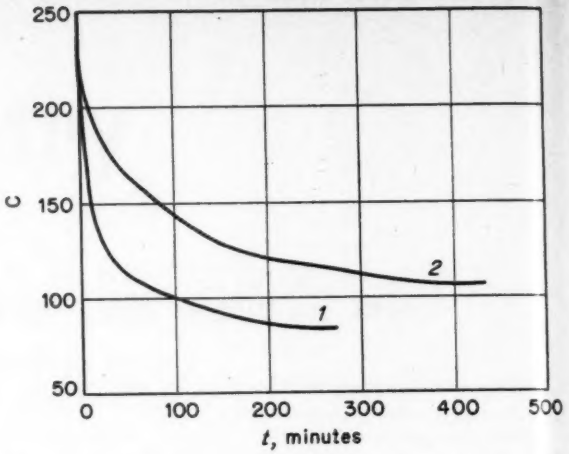


Fig. 4. Types of curves representing absorption loss vs. time: at 123°C. (Curve 1); at 102° (Curve 2).

equation

$$da/dt = k\,a^n \qquad (4)$$

Then one plots log k as a function of reciprocal temperature (1/T); this curve must be a straight line. Its slope permits a second estimate of W:

$$d\,(\log_e k)/dT = -W/RT^2 \qquad (5)$$

(b) The absorption is due to several species of centers. This is the general case for glass and silica. One attempts to operate under temperature conditions that make only one species disappear. If this is not possible, it is an indication that the various bands disappear as one phenomenon, or that the respective energies of activation are of one and the same order of magnitude.

The Study of Glass

The irradiated samples were microscope carrier glass of the composition:

SiO_2 : 60%
Na_2O : 22%
CaO : 15%
$Fe_2O_3 + PbO$: 3%

The absorption of the glass before irradiation is illustrated in Fig. 1. The increase of the absorption due to pile irradiation is given in Fig. 2.

The rates of bleaching were studied in the range of temperatures between 17 and 123°C. Figure 3 shows the entire absorption spectrum of centers disappearing with measurable speed in this temperature range. The shape of the spectra suggests the existence of three species of centers leading to local maxima of absorption at 340, 420, and 650 millimicrons. It is remarkable that these spectra have the same shape regardless of the temperature, within the range indicated, at which they were obtained. This means, as observed above, that the activation energy of the phenomenon causing the disappearance is essentially the same.

Two interpretations are particularly probable: (1) They annihilate by interaction; (2) A diffusion phenomenon of metallic ions governs their disappearance. One knows indeed[2] that the activation energies of the diffusion of sodium and calcium ions in glass are essentially the same.

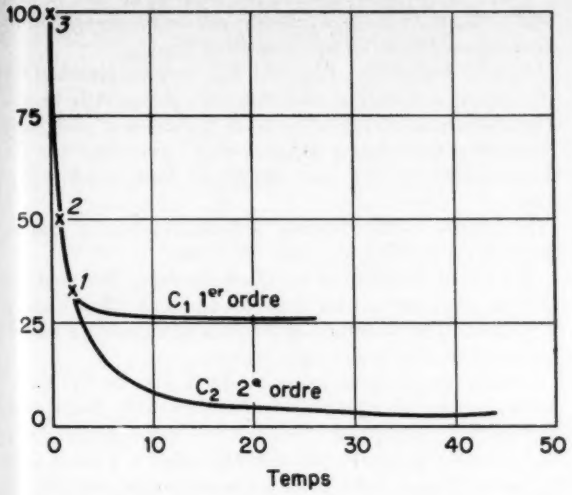


Fig. 5. Graph showing the type of theoretical curves passing through three points in the hypothesis of first and second order.

Energy of Activation. The first of the methods given above (equation (3)) yields for W a value of *20 kilocalories.*

Order of Reaction. The curves of Fig. 4 show the type of the disappearance of the absorption coefficient. One phenomenon, either of first or second order, cannot account for this type. Two simultaneous phenomena of second order do between 300 and 500 mμ. For the calculation of the corresponding coefficients k_1 and k_2, the assumption was made that the one is much larger than the other. Then, at first, the decrease is entirely due to the first phenomenon. From:

$$1/a = 1/a_1^\circ + k_1 t \qquad (6)$$

and the first three measurements at a given wavelength a_1 and k_1 was calculated, and from those a_1 for all times (t). The values of a_2 for the second phenomenon obtain by subtraction (Fig. 5).

These calculations were carried out completely for the wavelength 400 mμ. W is found about 20 kilocalories for both phenomena. Only k_1 can be calculated precisely for the entire temperature domain (Fig. 6). k_2 can only be calculated for 102°C. and 123°C. from which values W result as 21 kc.

Reheating experiments below 150°C. always yield curves containing two bands near 500 and 300 mμ. Only one branch of the latter is measurable because of the normal absorption of glass proper (Fig. 2). The two other bands do not become much weaker below 190°C.

The phenomena in ordinary glass thus appear quite complex. The study of fused silica, irradiated in the pile, was undertaken using the same methods in the hope of observing facts of the same nature, but greater simplicity.

The Study of Fused Silica

The various samples exhibit, prior to irradiation, an absorption spectrum of equal shape, but the absorption near 200 mμ might vary by 15%.

Blackening. The samples were all pile irradiated for periods up to one month. No saturation was observed. One sample irradiated by X-rays presented a spectrum of equal shape, but its bleaching has not yet been studied.

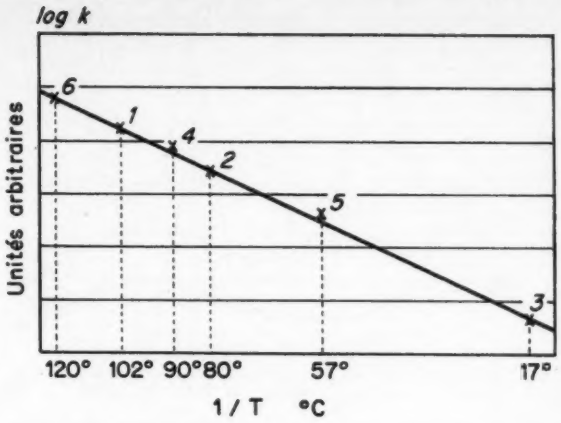


Fig. 6. Curve of log k = f (1/T) (k taken from experimental values under the assumption that the reaction is of the second order).

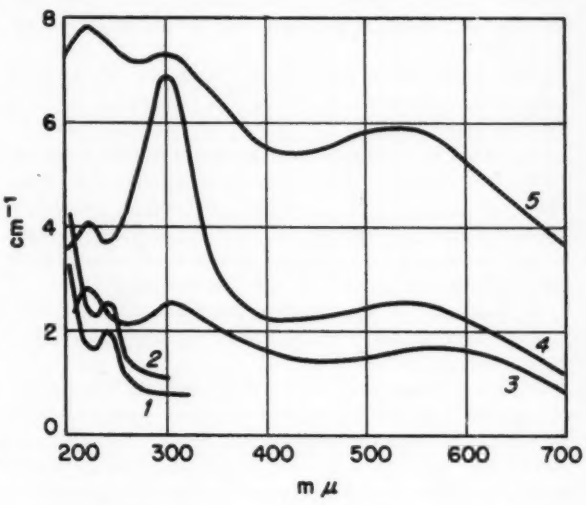


Fig. 7. Curve 1: Initial Absorption of Silica. Curve 2: Absorption after a cycle of 1 hr. at 700°C. (these curves are obtained by direct measurement; reflection losses are to be subtracted). Curve 3: Blackening after 150 hrs. in pile. Curve 4: same, for another sample. Curve 5: Absorption caused by 10 hrs. irradiation with x-rays of 45 kV, 15 mA, 15 cm from anticathode, Be window.

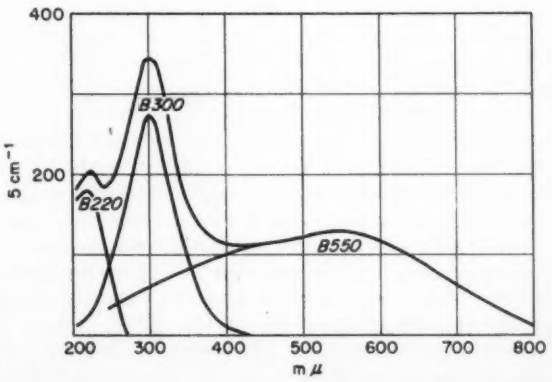


Fig. 8. Decomposition of pile absorption into three bands.

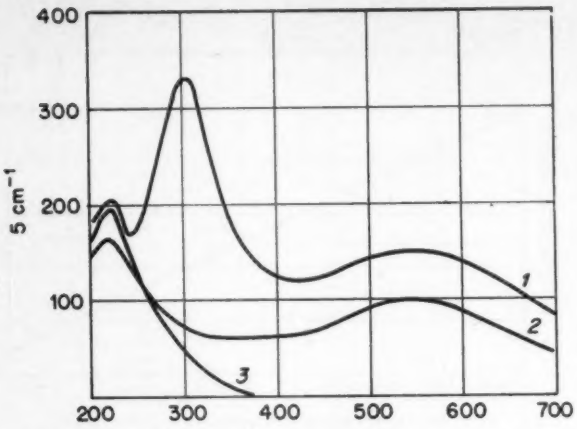


Fig. 9. Curve 1: Growth of absorption due to irradiation. Curve 2: What is left after 90 min. at 260°C. Curve 3: After 6 hrs. at 260°C.

Figures 7, 8, 9 show the existence of three absorption bands with maxima at 550, 300, and 220 mμ. They may be termed B_{220}, B_{300}, B_{550}, and the centers causing them C_{220}, C_{300}, C_{550}.

Thermal Decoloration. Figure 9 shows the type of phenomena observed. B_{550} and B_{300} weaken at 200°C.; B_{220} only at 400°C.

B_{550} and B_{300} weaken simultaneously at all temperatures; but when B_{300} has disappeared, an important fraction—about ⅔—of B_{550} remains. If samples presenting the same initial absorption are studied at different temperatures, it is found that there is always required the same amount of C_{550} to make the C_{300} disappear.

If the heating at the same temperature is extended, B_{550} continues to weaken and B_{220} is strengthened until B_{550} has vanished.

All this is true at 207°, 227°, 243°, 260°C. When heating is continued the spectrum is no longer changed. Only at 400°C. the spectrum moves again.

The rate of weakening is, at that temperature, a maximum for 220 mμ. Then the maximum is displaced towards 210 mμ. The same phenomena, at greater rates, occur at 500° and 600°C. Only at 700°C. is obtained a permanent spectrum, i.e., one that cannot be changed at any temperature. This absorption is of the same form but 20% greater than the initial absorption near 200 mμ Fig. (7). If the sample in this stage is reintroduced into the pile, the second blackening cycle is identical to the first and attains the same permanent absorption.

If an absorption band is due to only one species of centers, it weakens without deformation. This property is verified for B_{300} and B_{220}. Therefore, the difference in the absorptions at 300 and 350 mμ can be taken as a measure of the height of B_{300} and the kinetics of its disappearance studied. To the contrary, the measurement of B_{550} by a number such as a_{550} minus a_{650} leads to incoherences, which demonstrates that what is here called B_{550} is actually composed of bands that can not be spectrophotometrically analyzed at ambient temperature.

One finds that the disappearance of C_{300} follows, except at the outstart, a second order law, as witnessed by the nearly rectilinear form of curves $1/a = f(t)$ (Fig. 10). An activation energy of 46 kilocalories is associated with the phenomenon as demonstrated by the graph $\log k = f(1/T)$ (Fig. 11).

The analogous calculation for heating at 400°C. and 460°C. leads to an experimental activation energy of 70 kilocalories for the disappearance of B_{220}.

Optical Bleaching. B_{220} and B_{300} can be bleached by irradiation with light at all frequencies within their bands. The difference of the absorption before and after this irradiation furnished a supplementary procedure for the determination of the exact shapes of these bands (Fig. 12).

Irradiation with constant luminous intensity causes bleaching according to a first order law.

Review of Generalities on Color Centers. The analogy of these phenomena with those produced in alkali halides is evident. The essentials of the present knowledge on "F centers"[6] may be reviewed as follows:

Irradiation of these materials by a pile or by X-ray beams causes the appearance of a very high absorption band called an F band. This band is accompanied by a band located at shorter wavelengths called a V band, and by not so high a band at longer wavelengths called an M band.

For instance, in KCl the V band is found at 220 mμ, the F band at 550 mμ, the M band at 820 mμ.

Electrons trapped in a lattice point where a negative ion is missing are responsible for the F band. Density measurements prove that the irradiation does not only fill vacancies with electrons, but also creates these vacancies.

In the positive ion vacancies is settled the "positive hole," a center giving rise to the V band absorption. The M band is probably composite; its nature has not been determined.

The optical bleaching phenomena for F and V bands are particularly clear at temperatures where the vacancies are not mobile (below—80°C. in KCl).

One also can destroy F centers by simple heating. The disappearance often follows 2nd order laws[3, 4]. An experimental W can be determined. The theoretical interpretation is not yet clearly available. It is only known that it is the algebraic sum of several terms, especially

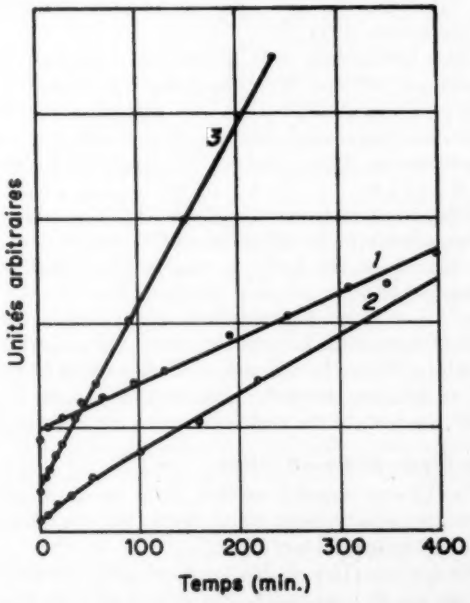


Fig. 10. Form of curves $1/a = f(t)$ (1) at 207°, (2) at 227°, (3) at 243°C.

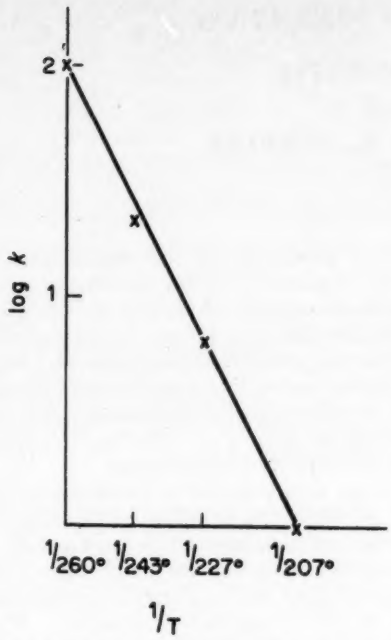


Fig. 11. Curve log k = f (1/T) for four different samples of silica having equal initial absorptions at start of heating period.

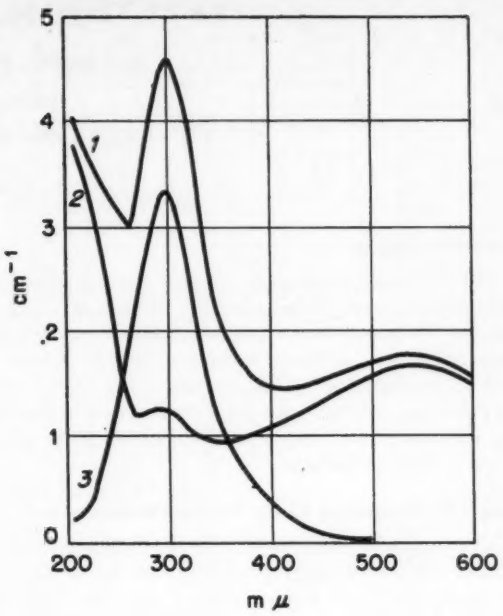


Fig. 12. Curve 1: Absorption upon removal from pile. Curve 2: After irradiation with mercury vapor light filtered through ordinary glass. Curve 3: Difference curve 1-2.

the energy of dissociation of F centers, half the energy of the formation of a vacancy pair, and, doubtless, also of the energy required to form a free positive hole.

Actually, the definitive phenomenon of this destruction must be the recombination of an electron and a positive hole.

A classical phenomenon regarding F centers is their migration to the anode when a colored crystal is placed into an electric field and heated. This phenomenon might also be produced for V centers, but is not well observable, as the V band is always in the UV.

Formulae Relative to F Centers. Smakula's formula permits the calculation of the number of F centers corresponding to the measured absorption:

$$n_o f = 1.31 \times 10^{17} \frac{n'}{(n'^2 + 2)^2} a_m \Gamma \qquad (7)$$

where n′ is the index of refraction, a_m the peak absorption, Γ the width of the band at mid-height.

A formula by Pohl relates the interionic distance d with the peak of the F band:

$$\lambda = 667\ d^2 \text{ (both } \lambda \text{ and d in Å)} \qquad (8)$$

In glass, neither the migration of centers in the electric field nor the optical bleaching are observed. Also, it would not seem justified to apply these formulae to glass; thus, there is no means to calculate the centers nor to interpret the values found for the reaction speeds.

However, in silica the use of these formulae and of the results reported above is justified.

Attempt of Interpretation for Silica. Crystalline silica has properties that relate it on the one hand to covalent, on the other to ionic crystals. X-ray analysis shows that the SiO_2 molecule has some real existence in silica in the sense that the Si atom surrounded by four oxygens is closer to two of them, namely at 1.63 Å, as compared to 2.18 for the others.

(Also the study of the transparency for monochromatic neutrons of vitreous silica[5] reveals a complex absorption spectrum. In the direction of decreasing energies, the first maximum, and the most marked one, is found for neutrons, the associated wavelength of which is 2.2 Å.)

Vitreous silica has a structure without any other regularity than that of the fundamental tetrahedron[2]. The density of vitreous silica is 2.2, of quartz 2.7.

In the following discussion, the 300 mμ band (B_{300}) is treated as an F, the B_{220} as a V band.

Pohl's formula (8) gives the interionic distance 2.1Å.

Smakula's formula (7) permits to obtain the number of centers C_{220} and C_{300}.

Numerical Data on B_{300} and B_{220}. Taking the physical constants of silica one obtains from (7):

$$n_o f = 10^{16}\ a_m \Gamma \qquad (9)$$

f is a dimensionless number somewhat below 1, as the F electrons or V "holes" lose some "optical force" (F. Seitz) by the interaction with complete layers of atoms present. f may be taken as 0.8 as for KCl. The width, at mid-height, of B_{300} is 1.2 eV.

The width, at mid-height, of B_{220} is 1.4 eV.

For instance, in a sample studied at 500°C., the number of centers upon removal from the pile was:

$$n_{300} = 3 \times 10^{16} \text{ centers/cm}^3$$
$$n_{220} = 4 \times 10^{16} \text{ centers/cm}^3$$

These values were found compatible with pile data in terms of collisions and effective projectiles (fast neutrons) during irradiations.

The numerical results of the experiments allow to take k from:

$$1/n = 1/n_o + kt \qquad (11)$$

On the other hand it is known that k is of the form (A independent of T):

(*Continued on page* 158)

ELECTRICAL GLASS MELTING

By DIPL-ING. I. HOROWITZ
Olten, Switzerland
TRANSLATED BY DR. S. R. SCHOLES

PART II

Furnace Types

Attempts have been made to melt glass electrically in the following types of furnaces: (1) Arc furnaces; (2) Induction furnaces; (3) Resistance furnaces; including those with: (a) Indirect resistance heating, where the heat is developed in special resistors; (b) Direct resistance heating, in which the glass itself serves as the heating resistance; and (c) A combination of direct and indirect resistance heating.

Arc and Induction Glass Melting Furnaces

The numerous trials with arc furnaces all failed on account of the discoloring of the glass by carbon particles of graphitic nature scaling off the electrodes. Maetz[19] describes one of the recent attempts. The furnace was developed by the A. B. Elektriska Ugnar, Stockholm. The arc plays over a bridge (bag-wall?) and only the radiant heat is used; thus, the contamination of the glass by particles from electrodes is prevented. Nothing further is known concerning experiments with this furnace or its practical use. Likewise, nothing has been disclosed concerning experiments with induction heating, with exception of the reports by M. George, of the electrotechnical laboratory of St. Gobain. One such release appeared of interest, disclosing that the discoloration problem, which causes so much difficulty in electrical glass melting, was much more easily solved with induction heating.

In the first induction furnace by M. George, two refractory nested pots or crucibles appeared, with a bath of metal between, heated by a high-frequency current.[20] The crucible of carbon or silicon carbide was, however, badly attacked by the fluid glass. The experiment failed because of the consequent discoloration.

M. George next proposed a low-frequency (50-cycle) furnace, in which the secondary circuit was a tin bath lying under the glass melt on the tank bottom and thus immiscible in contact with the glass. Tin is a metal that is fluid throughout a long temperature interval, between its m.p. at 232°C. and its b.p. at 2270°C. It is not attacked by molten glass and the glass should not pick up a trace of color. The mass of glass was moved by the magnetic field set up in the bath at the beginning of conduction. Nothing further is known concerning the outcome of the melting experiments, the energy consumption, or the introduction of such a furnace into practice.

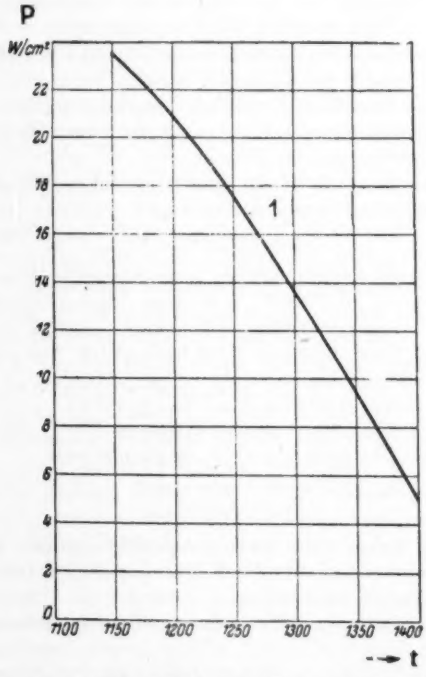


Fig. 7. Permissible Maximum-loading of Silicon Carbide Resistors as Related to Furnace Temperature. Open construction, without muffle: P. Maximum loading of resistor, in watts per cm²; T. Operating temperature of furnace; I. Curve for 1450°C. on the resistor.

Melting Furnace with Indirect Resistance Heating

J. Bronn carried out the first known experiments with indirect resistance heating. As a resistance, carbon granules were employed, packed between the sidewalls of the furnace and a melting pot placed in the middle. The experiment failed because this arrangement could not develop the required temperature, too long a melting time was required, and moreover, the pot developed rips and cracks.

Sauvageon succeeded in mastering the difficulties that baffled Bronn when he packed the carbon granules in the covering arch of the furnace. With such a furnace, which took a pot holding 450 Kg. of glass, he succeeded in reaching and holding a temperature of 1425°C. This experimental furnace was in operation 47 days, exclusive of warming-up time, and produced glass of good quality. The power required varied between 100 and 130 Kw. The energy consumption was about 6 Kw. hr. per Kg. of glass melted. Sauvageon's furnace is not suited for practical operation because the energy consumption is much too high.

Pot Furnaces with Silicon Carbide Resistors

In the 1930s, non-metallic resistors became available which would reach the necessary temperatures for glass melting. These resistors made of silicon carbide require no special protection against oxidation in a *normal* furnace atmosphere. They are sold in rod- or tube-form, under the trade names "Globar," "Quarzilit," and "Silit."

The first attempt to apply such resistors was made in 1932 by Brown and Boveri in Baden (Switzerland) with a small pot furnace and Globar rods. On the basis of en-

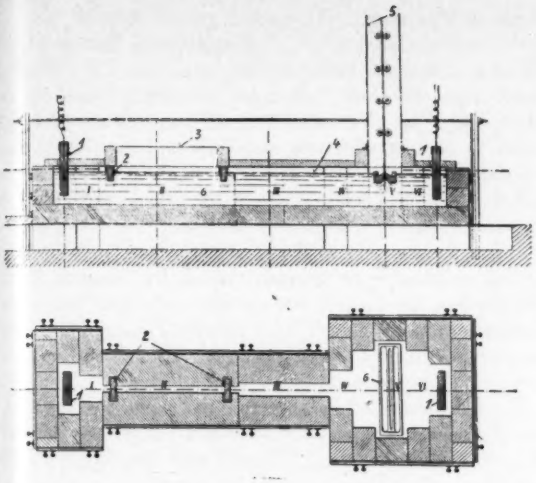


Fig 8. Electric Tank-Furnace by Sauvageon for Fourcault Window Glass: (1) Electrodes, (2) Floater, (3) Opening for charging batch, (4) Glass Surface, (5) Shaft of Fourcault Machine, (6) Debiteuse. I-VI, Separation of tank into cro-s-sections of various sizes to achieve temperature distribution. II, Melting zone. III, Refining zone.

couraging results, a larger furnace of this sort was built in a glass factory in Murano by Venedig. It used 60 Kw. for heating a 500-Kg. pot. The experimental operation in Murano produced a thoroughly melted and fined glass of high quality, easily worked. Energy consumption was 2.25 Kw. hr. per Kg. of glass.

The problem of electrical glass melting appeared to be solved, at least for pot furnaces. It was still not possible, in most instances, to operate economically. The reason was not the high energy consumption, but the great destruction of resistors. Gases evolved during the melting of batch attacked the silicon carbide more or less, depending upon the chemicals in the batch. Steam from moisture, or sulfur oxides from sulfate batches, or vapor from crystal glass were chiefly responsible.

Experiments were made to improve the situation by using a larger number of heating elements, but still a profitable level could not be reached, although the life of resistors was appreciably extended. The construction of the furnace sets a limit to the number of elements installed. As shown in Fig. 7, the allowable maximum loading of silicon carbide heating elements falls off rapidly with increasing operating temperature. In electric-glass pot furnaces, the elements are occasionally much overloaded, and the life of these resistors is accordingly shortened.

The prospect of making such furnaces of larger dimensions and with more pots and thus achieving economical operation is limited by the maximum size of the heating elements, which today can be supplied with a maximum length of 1.75 meters and diameter of 50 mm. (5'9" x 2").

Tank Furnaces with Silicon Carbide Resistors

One such tank furnace has been in operation for several years in Martigny (Switzerland). It behaves as a small tank furnace with a rather limited capacity. The flint glass for hollow ware there produced is good. Because of the limited length of the Silit rods, 1.75 m., the inside

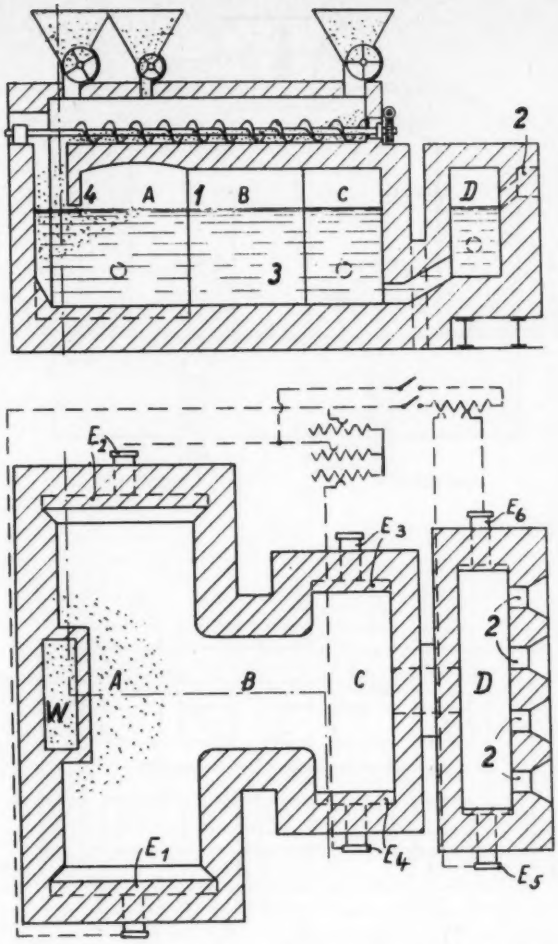


Fig. 9. Raeders' Furnace with Direct-Resistance Heating: (1) Glass surface; (2) Working openings; (3) Glass bath in usual tank furnace; (4) Melting batch. E_1-E_6 Electrodes: (A) Melting chamber; (B,C) Refining chamber; (D) Working tank; (W) Filling chute for batch.

breadth of the melting chamber can be only 1.2 to 1.3 m. Its capacity is thus quite small. Proposals[24] have been made to build tanks in parallel sections under separate crowns so that the span of each arch would be small enough to accommodate the heating rods.

Melting Furnaces with Direct Resistance Heating

All experiments along this line have been made with tanks.

Sauvageon's Furnace

Sauvageon[25] made the first attempt with direct resistance heating with his 1905 project[26] for a window-glass furnace using the Fourcault process.

After several experiments with small units, Sauvageon built a tank holding 10 tons of glass. The power input reached an average of 300 Kw. for a daily production of 1.5 tons corresponding to 4.8 Kw. hr. per Kg. Although electrodes of especially pure graphite were employed, only poor glass could be made, unfit even for green bottles and badly discolored.

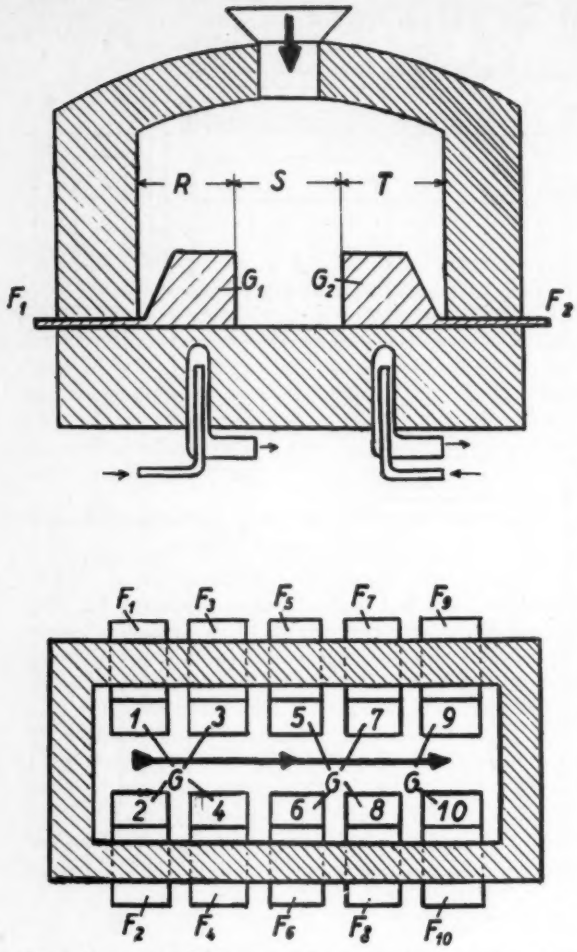


Fig. 10. Principle of Cornelius' Furnace: G_1—G_{10} Electrodes; F_1—F_{10} Current leads.

Raeders' Tank Furnaces

At about the same time, Raeders, in Oslo, Norway, and also Cornelius, in Kungelv, Sweden, reached a solution to the problem of glass melting by direct resistance heating.

In one industrial installation operated for three months in Moss, Norway, the following data were obtained: The furnace was built for 5 tons per day with a power input of 200 to 250 Kw. However, production was easily brought up to 9 to 10 daily tons, making the energy needed only 1.1 to 1.2 Kw. hr. per Kg. Glass temperatures reached 1600°C. Fig. 9 shows the furnaces designed for three-phase current. The ware, mostly bottles, was of good, marketable quality. A characteristic feature of the furnace is that the electrodes are built into the walls and reach into the glass.[27] Because the batch floats on the glass bath, the electrodes beneath the surface did not come in contact with raw materials and the risk of discoloration was reduced. It is the alkali members of the batch that would cause most of the attack and result in carrying coloring matter into the glass. Raeders pointed out that temperature at the contact surface must be kept as low as possible to minimize attack by the glass itself. To this end, the current density was to be kept below the ordinary value of 3 to 9 Amp. per sq. cm., and the pure graphite electrodes were to be placed in lateral bulges, removed from the hottest zone of the furnace.

Raeders described another furnace in which the working chamber was done away with and replaced by a bowl-shaped bulge because this furnace was designed for fully automatic glass forming machine supplied by a feeder. The electrodes were no longer built into the walls; their outer ends were water-cooled. Also new was the form of the tank and the arrangement of the melting phases vertically over one another so that the glass flowed in columnar fashion. Nothing is known concerning any industrial application of the Raeders furnace, notwithstanding the successful results in operation.

Tank Furnaces by E. Cornelius

At about the same time as Raeders, E. Cornelius developed in Kungelv his electrical melting tank,[29] using in the same way direct resistance heating. The furnace is heated by completely immersed metallic electrodes made of pure iron, very low in carbon (carbon 0.03%). For the protection of the tank walls, the electrodes stand free and form a border for the melt in which the glass flows from the charging end to the working end (cf. Fig. 10).

Cornelius carried out large-scale trials of his furnace in Kungelv. His first furnace made green and amber bottle glass of satisfactory quality. A second furnace ran nearly 15 months, and the results were quite successful. Attempts to make colorless glass with the Cornelius furnace were made by Pilkington Brothers, in conjunction with the British Hartford-Fairmont Syndicate, at St. Helens, England. According to reports by E. Meigh,[30] it was possible only during a short period of operation to hold the iron content of the glass low enough to permit good decolorizing.

There is no doubt that the Cornelius furnace in its original form was adequate for making colored glass for bottles. The results are amazing when it is considered that the electrodes continuously in contact with the glass

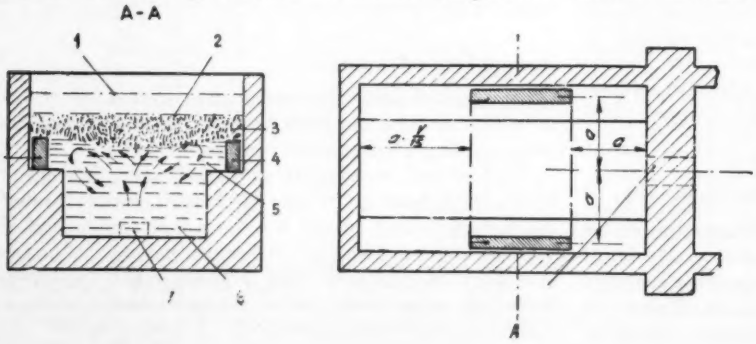


Fig. 11. Electric Melting Installation of N. Amer. Cyanamid Co., after the Cornelius System: (1) Maximum height of floating batch, (2) Minimum height of floating batch, (3) Batch, (4) Electrodes, (5) Melting zone, (6) Refining zone, (7) Submerged throat between melting and working chambers.

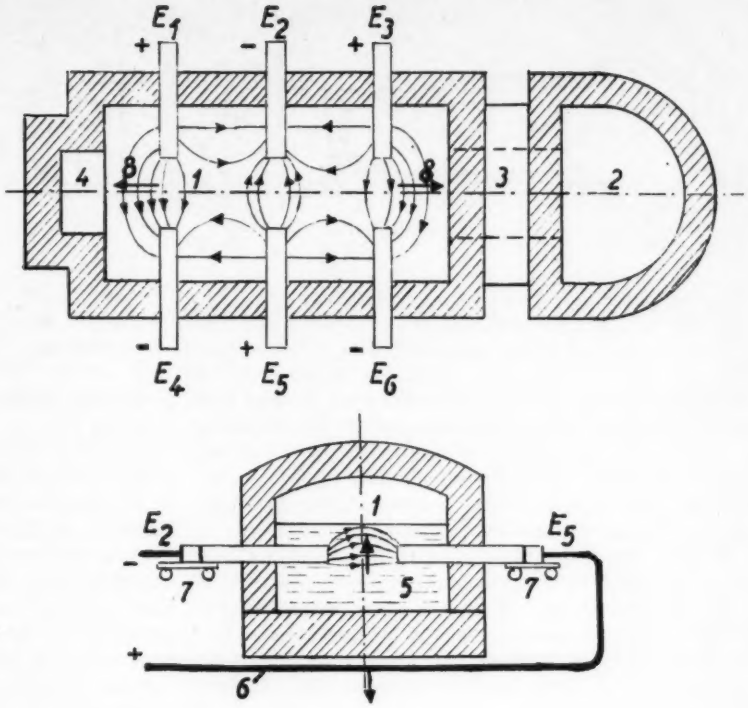


Fig. 12. Souchon-Neuvesel Melting Tank: E_1—E_6 Electrodes of large diameter; (1) Usual melting tank; (2) Working tank; (3) Deep Throat; (4) Charging opening; (5) Glass bath; (6) Return current from middle electrode, for electro-dynamic effect; (7) Arrangement for placing electrodes to regulate immersion; (8) Electro-dynamic effect.

weighed a total of about three tons,[31] whereas, if a piece of iron weighing 20 to 40 kg. were immersed in an ordinary tank, the glass would be ruined and the tank would require draining.

Melting Water Glass; Cornelius System

In 1938, Y. R. Cornelius reported[32] that installations by the American Cyanamid Company for melting water glass (sodium silicate) had been in operation for five years.

The installations consisted of two melting tanks, one making 20 tons and the other 30 tons per 24 hours. Each furnace had a melting chamber and a small drawing chamber, connected by a submerged throat. No crown was used, the upper surface of the melt being covered by the batch.

The furnaces were the Cornelius type formerly built as experiments in St. Helens. Certain difficulties arose for, when the bench-wall supporting the electrodes corroded away, the front portion sank causing distortion of heat distribution in the melting-bath. Current distribution was badly disturbed. In the new construction of 1933, bench-walls 30 cm. wide and 45 to 60 cm. high were provided, lengthwise, on each side of the melting chamber, and the electrodes now rested on these walls. The conducting plates, 15 cm. thick, were led vertically about 15 cm. through the layer of floating batch, thence horizontally through the sidewalls of the furnace. This arrangement assured a partial cooling of the electrodes by the cold charged batch.

The practical results were quite satisfactory. The furnace campaign lasted 15 to 17 months. Energy consumption ranged from 0.88 to 0.91 Kw. hr. per Kg. sodium silicate, measured on the high-tension side of the transformers. This average loading was occasionally overstepped, but reached for many months only 0.725 Kw. hr. per Kg., measured on the low-tension side.

The Cornelius furnace used single-phase current, which hitherto could be obtained from a polyphase system only by means of a rotary converter, because the coupling of a large single-phase load produced a highly undesirable, unsymmetrical load on the polyphase system. Recently, however, technical controls have been developed, in which the Scott-connection was used in the regulating transformer, which changes the polyphase current to two-phase and connects the furnace to the net.

Electric Furnaces in the Souchon-Neuvesel Factory

The glassworks "Verreries Souchon-Neuvesel Richarme et d'Evian Reunies," brought into operation in Givor shortly before the outbreak of the Second World War, had an electrical melting furnace for producing bottle glass. The results were so good that a second installation was built in St. Etienne.

Graphite electrodes of large diameter were used, arranged in pairs in the longer walls of the S-V furnaces. The electrodes reach far into the furnace and the depth of immersion can be regulated. The process is covered by Swiss Patent 225,958.

Electrode arrangement and furnace connections are shown in Fig. 12. Low current density is assured by the large diameter of electrodes. As claimed in the patent, the Souchon-Neuvesel procedure, because of the connections, brings about a definite "spring" where the glass in the melting tank has its highest temperature, according to the most recent knowledge of convection currents (cf. Fig. 2). This effect is promoted by the electrode connections whereby adjacent and opposite electrodes have opposite polarities. The patent specification also discloses

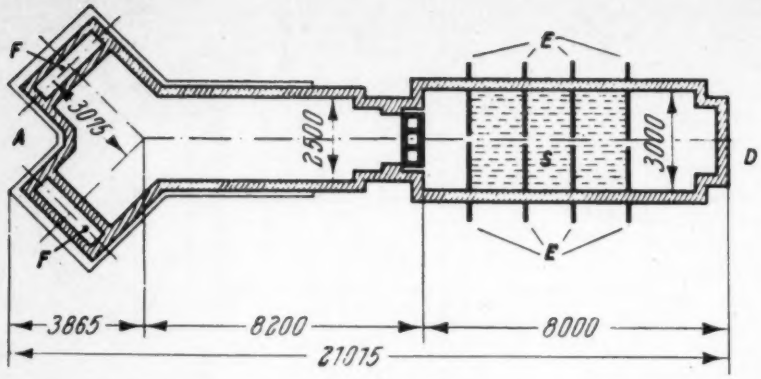


Fig. 13. Borel Furnace at Electroverre Romont: (D) Charging end; (S) Melting tank; Electrodes, (A) Fourcault installations; (F) Drawing shafts for F. machines.

an electro-dynamic effect, which takes place between two parallel conductors. As portrayed in Fig. 12, this effect is reached by arrangement of the return current of the middle electrode, which flows under the middle of the melting tank, and it promotes convection currents in the glass to the improvement of mixing and homogeneity.

The Souchon-Neuvesel process was fully successful, and it was applied to other glass tanks in France, as well as in the original factory. Energy use was in general 2.3 Kw. hr. per Kg. Two glass plants in Switzerland now use the same S-N system. One of these, where window glass is made by the Colburn (L-O-F) process, will be further discussed below.

Combined Direct- and Indirect-Resistance Heating; Sauvageon Tanks

It was Sauvageon again who first made experiments with two heating circuits. One of the trial tanks was 3 x 1 meters in size. A temperature of 1500°C. was reached. The glass was better than Sauvageon made with direct resistance heating, but was still not free from defects.

The Installation at Electroverre Romont

The tank furnace at Romont, in which Fourcault window glass is made, is 27 m. long. It was put in operation in March, 1936, and has operated for 16 years, producing clean, well-fined window glass, free from cords and other defects (¾-white). The tank is planned for a daily output of 24 tons, although during the first 9 years the pull was 20 tons per 24 hours. The connected power is 2600 K.V.A., of which only 800 to 1000 K.V.A. is required for an output of 10 tons in 24 hours, making the energy used 1.8 to 2.4 Kw. hr./Kg. Attrition of the tank is notably less than it would be with oil- or gas-firing. Temperatures are closely regulated within variations of 5 per cent.

The thermal and electrical studies were made by E. V. Borel, engineer, with the cooperation of the Freiburg Electrical Works. The electrical heating of the furnace was furnished by the firm Borel, S. A., in Peseux (Switzerland).

During the winter of 1945-,46, the capacity of the unit was doubled by installing a second Fourcault machine on a Y-form working end and by widening the melting-chamber by one meter. The furnace, whose measurements can be taken from Fig. 13, has a production of 25 to 28 daily tons, with a requirement of 1.8 to 2.0 Kw. hr. per Kg. of window glass.

Electrodes for heating the melting tank have the form of round rods, and consist of graphite. The cross-section is so limited that not only direct resistance generates heat, but also the electrode itself as a resistor. Heat from the electrode adds to the heat generated in the glass.

Fig. 14 shows the general arrangement of the electrodes in the Electroverre Romont installation. The electrodes lie across the direction of the stream of glass in the tank, near the surface, but immersed. Two opposite electrodes extend into the tank until they almost meet. The furnace is so connected through a step-wise transformer to the polyphase power supply that the current in the glass flows not only in the lengthwise direction of the tank, but also through the glass lying between ends of electrodes in the middle of the tank. This is accomplished, according to Swiss patent No. 232,835, in this manner so that either by connecting electrodes lying opposite each other to the same phase, one receives a higher E.m.f., or by connecting the electrodes of a pair to the same phase. The current flows chiefly in the direction of the stream of glass in the bath. Since the furnace is connected to a polyphase source through a regulating transformer, the voltage of the several phases can be individually regulated. Thus the main glass current, and with it the temperature development in a longitudinal direction in the furnace, can be influenced and the desired melting curve can be reproduced. As previous discussion has shown, the currents in the glass in the tank are essentially of a developed nature and are strongly influenced by thermal currents. In the electrical tank at Romont, the separate electrodes work as heating elements, and at these spots the glass becomes hotter and rises, forming a number of "springs" distributed lengthwise of the tank.

The working chamber with Fourcault forehearth, as operated by Electroverre Romont S. A.,[34] is heated by supplementary metallic resistors. On the sides of the

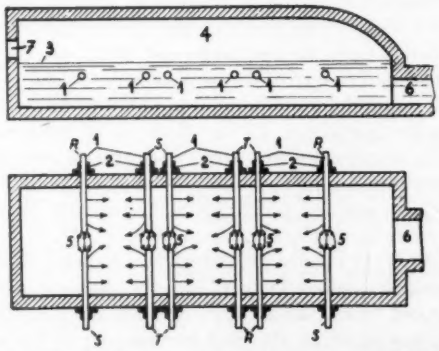


Fig. 14. Electrode Arrangement in the Borel Furnace.

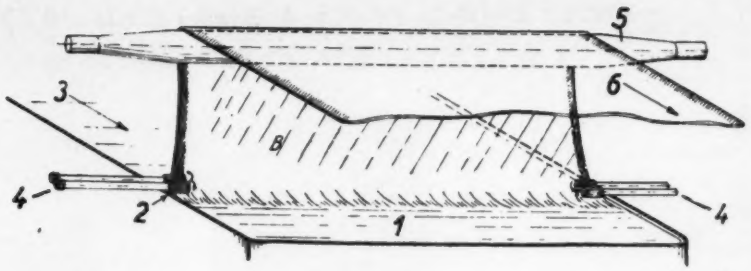


Fig. 15. Schematic Illustration of Colburn (L.O.F.) Process.

debiteuse are two angular electrodes of a supplementary circuit, which heat the glass as it enters the debiteuse. Besides, the glass in the drawing chamber is heated by still another current, carried by electrodes similarly introduced and arranged as those in the melting chamber.

Other Electrical Tanks of the Above Systems

These installations having been successful in the parent plants, equally good results were expected from new installations. A whole series of electrical glass melting furnaces have been built in Switzerland in recent years. Most of these followed the "Electroverre Romont" system, while two were built according to the "Souchon-Neuvesel" plans. The majority of these installations have proved themselves for over eight years of operation. Green bottles were made in most of them, but a few electric tanks made amber bottle glass, and some were devoted to lamp-bulb production. Lack of fuel during the War gave impetus to this development. Results were on the whole satisfactory and clean, clear glass was produced. The general opinion was that operating results were so good that today, after the return of a normal fuel supply, electrical heating is retained because of its inherent advantages.

The electrodes consist of graphite. On account of wartime limitations, the best quality of graphite was unobtainable and common graphite was substituted. Nevertheless, careful operation made it generally possible to get glass free from discoloration.

One installation is a bottle factory with two electric tanks. One of these requires 500 Kw., has a melting chamber holding 22 tons, and yields 5 tons per 24 hours. The larger tank needs 1500 Kw., holds 50 tons, and delivers 15 tons per day. These yields cannot as yet be exceeded. These "Romont" system tanks require 2.3 to 2.4 Kw. hr. per Kg. of glass melted.

The second Swiss works producing window glass changed its melting practice over to electrical heating in 1946, installing the "Neuvesel" system. Window glass was here produced by the Colburn process, in which the glass sheet is drawn, in the usual sense of the word, from the glass bath in a continuous ribbon. In contrast with the Fourcault process, there is no debiteuse, and the bottom end of the sheet is not urged upward by hydrostatic pressure. The danger of progressive narrowing of the sheet is here overcome by the use of narrow, knurled rolls, gripping the edges of the sheet a few cm. above the bath surface, and exerting a small outward pull upon it that maintains it at full width. Fig. 15 shows a schematic picture of the Colburn drawing process. The sheet issuing vertically from the bath is conducted over a bending roll, then horizontally through the drawing apparatus and the annealing lehr. This installation requires 4000 Kw. for a daily pull of 35 tons of window glass, or 2.3 Kw. hr. per Kg.

Recently, this plant making window glass by the Col-

(*Continued on page* 160)

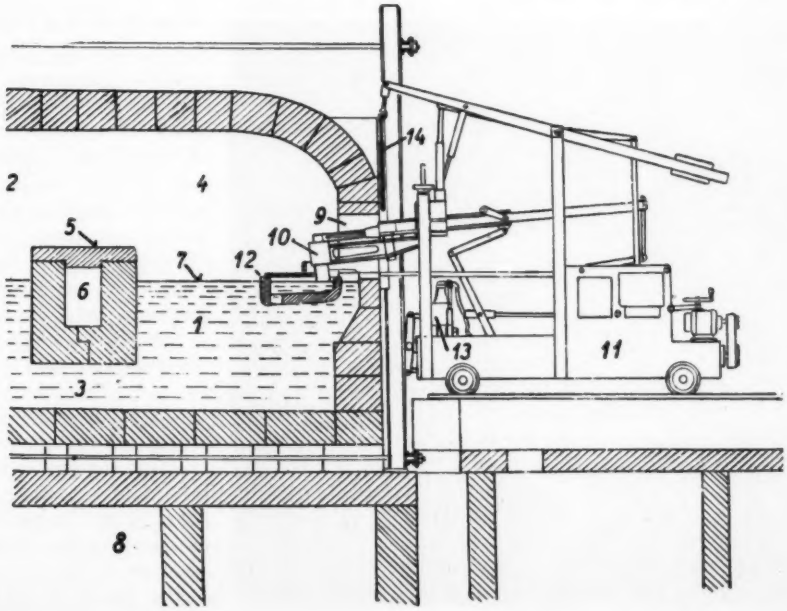


Fig. 16. Melting Tank with Automatic Blowing Machine Directly Attached.

PRECISION LENS PRODUCED WITH PRECISELY CONTROLLED TEMPERATURE PROGRAM

Precision, quality, skill, and craftsmanship, plus engineering know-how, are obviously prime requisites in the production of optical material, whatever its ultimate use. This is strikingly demonstrated at the American Optical Company, Southbridge, Mass., during the development and production of glass television theater-projection lenses. Here, under conditions automatically and precisely controlled by integral cam program controllers, production of giant 22-inch diameter corrector lenses and other optical parts for theater television projection systems is underway.

Initially, American Optical engineers were asked to collaborate with RCA and General Precision Laboratories to perfect a system for projecting a television image onto a theater screen. The method evolved incorporated a Schmidt optical system. This comprises a mathematically corrected mirror and a 22-inch diameter corrector lens. The system projects an image, magnified 48 times, onto a 15 foot by 20 foot screen from a distance of 60 feet. Projected pictures are normal and in perfect focus. As a result of the innovation, orders for theater television equipment are steadily increasing, RCA officials report.

Fig. 1. American Optical Company, Southbridge, Mass.

Fig. 2. Furnace room showing three of the furnaces used for forming corrector lenses. Note thermocouples at tops of furnaces.

Glass Correcting Lens Requires Special Forming Technique

Key to the excellent optical performance of the projection system is the precision with which the corrector lens is shaped. The method employed is to first grind a refractory block to the exact curvature desired for the corrector lens. A surfaced clear glass disc is then placed on the block and the combination is placed in a furnace with the glass uppermost. Heat is then applied until the glass assumes the shape of the refractory block. Individual furnaces are used for each refractory block-lens combination.

Since both the glass and the refractory block will withstand only a small rise in temperature per hour, the application of furnace heat must be gradual. Similarly, the drop from the maximum or flowing temperature must be gradual. Any abrupt temperature change will crack the refractory block, glass lens, or both. Therefore, furnace temperature must be brought up to the required flowing temperature and brought back to room temperature in accord with a definite time-temperature pattern. Moreover, before cooling the glass lens, it is necessary to provide an annealing period for stress relief, during which furnace temperature is maintained at the proper level.

Cam Program Controllers

Uniform and precise conformance to the proper established time-temperature schedule of heating, annealing, and cooling is achieved through the use of an electronic circular chart, cam-operated program controller, developed by Minneapolis-Honeywell's Industrial Division. Each controller embodies an integral cam with follower to position the set point index of the associated control potentiometer. The cam is made of transparent plastic, graduated to correspond to the recording chart, and permit observation of the chart record of temperature at all times, regardless of cam position.

The cam is readily cut to a shape to conform to the required time-temperature cycle for accurately forming the corrector lens. In operation, the cam revolves so as to make one complete revolution for the entire heating-annealing-cooling period. During this revolution, the cam follower continuously positions the control index of the temperature control section of the instrument, thereby resetting the controlled temperature so as to adhere at all times to that called for in the established time-temperature cycle.

The speed of revolution of the cam is such that a

Fig. 3. Unloading No. 3 furnace. Operator is removing finished corrector lens. Notice the refractory block still in the furnace. Butt-welded thermocouple tip (arrow) is projecting through cover of the furnace.

Fig. 4. Loaded furnace in operation showing ElectroniK cam-operated program controller. The thermocouple head is in center of furnace.

single revolution is made in one 36-hour period. During this revolution, the complete time-temperature program is executed. This comprises: temperature rise per proper gradient to flowing temperature; maintenance of proper annealing temperature for required period for relief of stresses; and temperature reduction per proper gradient to ambient conditions.

Control Effected Through Furnace Temperature Measurement

Maintenance of the proper time-temperature program is directly dependent upon accurate measurement of furnace temperature. A butt-welded thermocouple of platinum, rhodium-platinum (R calibration) is installed in the cover of each furnace. This thermocouple measures the furnace temperature through a range of 0 to 2,000°F. Inside furnace temperature is sensed by the exposed hot junction of the thermocouple.

An integral part of the cam-operated program controller, the null-balance type Electronik potentiometer, evaluates the emf output of the thermocouple. The emf varies in accord with furnace temperature. Thus, the balanced position of the potentiometer evaluates this emf which constitutes the indication of furnace temperature. From this measurement of furnace temperature, control is effected.

With the potentiometer equipped with control switch mechanisms, deviations from the set point temperature produce switching actions which operate contactors that, in turn, cut the power on and off of the electric heating elements in the furnace. Since the furnace load remains constant, on-off control action maintains constant furnace temperature with respect to the set point of the instrument. The set point of each instrument is automatically positioned directly by the cam follower. As a result, the furnace temperature is continually maintained at the set point temperature called for by the program to which the plastic cam is cut.

Electric Heating Elements Provide Uniform Heat

Ribbon-type electric heating elements are installed on the inside of each furnace, on top, bottom, and side. This arrangement provides uniform distribution of heat to all sides of the corrector lens, and thereby assures correct processing temperatures for the lens itself. Moreover, with even distribution of internal furnace heat, the control of the furnace temperature throughout the entire time-temperature cycle is greatly facilitated.

Controllers, contactors, and switches are all mounted on the same frame, which, in turn, is mounted on the wall. To lessen vibration effects from the contactors and possible adverse effects upon lens formation, all units on the wall panel are rubber mounted. In operation, contactor noise and vibration are practically negligible. Care in regard to details such as this, plus skilled use of instrumentation techniques and expert craftsmanship in the necessary manual operations, have combined to insure the precision necessary to the production of theater television projection systems which bring enjoyment to many.

• Dr. C. Arne Arenberg, former technical research adviser to the Catalytic Construction Company, has been named a physical chemist at Armour Research Foundation of Illinois Institute of Technology. Dr. Arenberg will work with the Foundation's Ceramics and Minerals department, Dr. Einar P. Flint, department chairman, has announced. A specialist in physical chemistry and thermodynamics, Dr. Arenberg has had extensive experience in industry.

A new tool for

Glass Plant Executives

Research Heads

Laboratory Technicians

Engineers

Technologists

FAY V. TOOLEY, *Editor-in-Chief*

Glass Compositions
Aaron K. Lyle, *Hartford-Empire Company, Div. of Emhart Mfg. Company*

Physical Properties of Glass
Donald E. Sharp and A. E. Badger, *Libbey-Owens-Ford Glass Company*

Raw Materials
Samuel R. Scholes, *New York State College of Ceramics, Alfred University*

Procurement of Materials, Supplies and Services
C. L. Rice, *Owens-Illinois Glass Company*

Batch Materials Handling and Preparation
W. Ronald Lester, *Pittsburgh Corning Corporation*

Furnaces and Fuels
Franz G. Schwalbe, *Toledo Engineering Company*

Instrumentation in the Glasshouse
John R. Green, *Minneapolis-Honeywell Regulator Company*

Refractories
W. L. Fabianic, *Owens-Illinois Glass Company*

The Glass Preparation Process
F. V. Tooley, *University of Illinois*; Mellen A. Knight, *Minnesota Mining & Mfg. Company*; Aaron K. Lyle, *Hartford-Empire Company, Div. of Emhart Mfg. Company*; Victor C. Swicker, *Alexander H. Kerr & Co., Inc.*; and Axel Ottoson, *Imperial Glass Corp.*

Feeding and Forming
H. H. Holscher, *Owens-Illinois Glass Company*

Annealing and Tempering
Harold A. McMaster, *Permaglas, Inc.*

Glass Decorating
V. H. Remington, *B. F. Drakenfeld & Co., Inc.*

Auxiliary Information and Tables
F. V. Tooley, *University of Illinois*

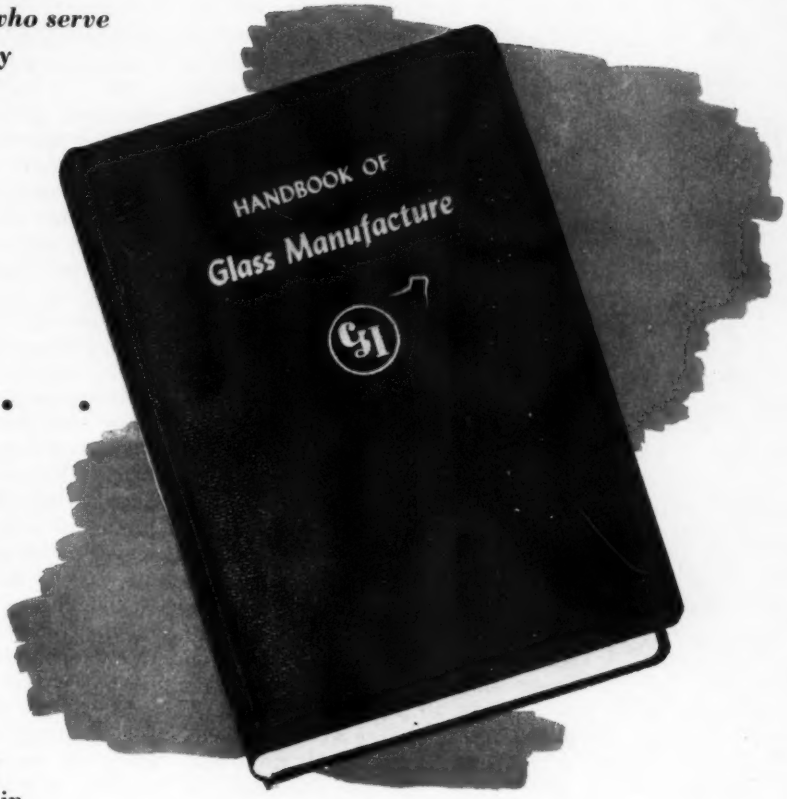
THE NEW HANDBOOK OF GLASS MANUFACTURE is comprised of more than 500 pages of practical reference data—tables, charts, formulae, illustrations, and text—on all phases of glass manufacture. Each section has its own table of contents, in addition to the master table. A comprehensive index provides quick reference to the contents of the entire book.

Basically, the HANDBOOK OF GLASS MANUFACTURE is intended to give those engaged in glass manufacturing operations a starting point, or point of orientation, with respect to particular problems confronting them. By becoming familiar with materials, apparatus, equipment, and principles relating to a given problem, and with points of view that have proven successful on similar problems in the past, this new Handbook should enable those who use it to get off to a better start in solving a given problem.

It is a primary working tool for plant executives, research heads, laboratory technicians, and engineers. It is complete enough to be used as a text or reference work for a course in glass technology. It can also be used effectively by glass companies as a source of reference to many of their customers and others who wish to obtain a general knowledge of glass manufacturing.

This new handbook is the product of many individuals, each one particularly qualified to handle the subject assigned to him—a truly collaborative effort. Those who have made this book possible and their subjects appear in the opposite column.

The Handbook of Glass Manufacture is the only book of its kind, and for all who are engaged in glass manufacture and those who serve the industry — it is as necessary as sand in the batch.



Twelve years ago, the Ogden Publishing Company, publishers of The Glass Industry, produced the first handbook ever to be published for the glass manufacturing industry. This book was widely received but so much has taken place in the intervening years in technological and engineering development and in operating techniques that there has been an ever increasing demand by glassmen for a modern and more comprehensive working manual.

After more than three years of planning, preparation, compiling and editing, we now offer to the glass manufacturing industry the *new* HANDBOOK OF GLASS MANUFACTURE.

The Glass Industry
55 West 42nd Street, New York 36, New York

Date.....

Enclosed please find remittance in the amount of $..... to cover the cost of ..... copies of the HANDBOOK OF GLASS MANUFACTURE. Single copy price, $11.50. Order for 5 or more copies, 10% discount. Add Shipping and Insurance charges, domestic 50c; foreign 80c. Foreign remittance in U.S. dollars.

NAME.....

COMPANY.....

STREET..... CITY..... STATE.....

PROVIDING INFORMATION FOR THE GLASS INDUSTRY

By JOHN T. OGDEN, Publisher

Ogden Publishing Company, New York, N. Y.

So far as I can remember, this is the first talk ever scheduled at any meeting of glassmen on the subject of publishing. This makes me even more aware of the honor conferred upon me to speak not only on this subject, but as the representative of the entire business press of the industry. May I also express my appreciation to my fellow publishers, many of whom have written me their suggestions and offered their cooperation wholeheartedly. And finally may I speak, too, of the personal pleasure it gives me to meet with you men; besides and beyond the opportunity of renewing many friendships of long standing—such a meeting as this is tremendously stimulating—I don't know of any other place in our world of glassmaking where a greater "know-how" is represented than right here within these four walls.

When the assignment for today's talk was first handed me, I thought the chore would be a fairly simple one. Having spent twenty-four years publishing for the glass industry, I felt it would not be too difficult to pull enough rabbits out of the hat to provide subject matter for a talk—even an interesting talk. But when I got to close grips with my pencil, I soon discovered something—and I am sure each and every one of you has had the same experience at one time or another; that when you live with your job long enough, the whys and wherefores of what you do become somewhat automatic. They are somewhat like reflexes, and their analysis eludes you.

Reflexes, in a sense, are the things you do automatically, without thinking about them. You live with them so continually, day in and day out, that you take them for granted. And this makes me think of the parallel they probably offer to your own thinking, when you think about your business press—don't you take it pretty much for granted, without stopping to analyze the whys and the wherefores?

And here we move very logically to another thought. You see the business press through the eyes of a glassman. But have you ever seen yourselves as the business press sees you? It might be interesting to have such an experience, and I'll make a try at it.

Looking about this room, I am aware of the characteristics of my audience. I would say that factory men—production men—predominate. A close second in numbers to this group would be the supply men, suppliers of your materials and services. I doubt whether many of the scientists are here, the clientele which Charlie Pearce woos so assiduously with his *Journal*. And may I give Mr. Pearce a plug and recite the full name: *The Journal of the American Ceramic Society*. There are some technologists. And being as we meet in a university town, I can include a sprinkling of students from Ohio State University.

Now, what have I been doing? I have been analyzing my audience. And the analysis of his audience is the first step a business paper publisher must take. When he can find enough people with enough related interests, he has *one* of the essentials required for publishing a business paper—potential circulation.

But not any kind of reader audience will do; it must command purchasing power. By purchasing power, I mean it must have a determining say-so as to what a company buys, and where it buys it. The reason the publisher must have purchasing power among his readers, whether that power be direct or indirect, is that he can't sell advertising unless they have it. I'll come to the importance of advertising later. For the moment, please take my word for it that advertising revenue is what permits the publication to exist.

Once a publisher decides he has a numerically adequate reader audience that will buy the commodities he hopes to see advertised, he carries his analysis one step further: what are their interests? By mapping out precisely their major interests in glassmaking, he can decide whether he is going to publish a production journal, a book devoted chiefly to news, to the wholesale or retail market, or perhaps a chatty gossip sheet. He may decide that he can do the best job by publishing a vertical book; that is, one devoted to glass exclusively, such as THE GLASS INDUSTRY; or he may, like the publisher of *Ceramic Industry*, decide on a horizontal approach, in which he cuts through several industries which he feels to be related. Virtually every industry has room for all of these types, and we have fine examples of them in the glass field. Finally, depending upon decisions made at this point, the magazine may be issued weekly, bi-weekly, monthly, or perhaps even quarterly. For example, in an active industry, spot news might easily become stale if held for a month. And on the other hand, carefully thought-out "how to do it" articles cannot be rushed into print, nor could such a heavy protein diet be properly absorbed by the reader if fed to him with too rapid frequency.

It is time now to apply these publishing generalities to the glass industry specifically. Let us take a look at the manufacturing set-up of glassmaking. A close estimate of the number of glass manufacturing plants would be somewhat over 300. But anyone at all familiar with the facts knows at once that this is an over-simplification; there are many different kinds of glassmaking plants, and some of these bear very little resemblance to the rest.

The largest group numerically comprises the pressed and blown ware. This is based on Arthur Kimes' excellent and widely used *Glass Factory Directory*. But while the pressed and blown group is large numerically, yet, in the dollar value of its operational needs and tonnage-wise, it is smaller perhaps than any other. Its characteristics reflect themselves in its readership needs. A great service a publisher could render the majority in that field lies, as I see it, in the sale of its ware. Here the glass manufacturer becomes the advertiser, and his customer the reader, to a large extent at least, but such a magazine ceases to become a glass paper.

Having eliminated the pressed and blown group, we are left with what? A number of groupings, each of them small numerically, however impressive their com-

---

Presented before the Thirteenth Conference on Glass Problems, Ohio State University, Columbus, Ohio.

bined operations may be rated industrially. We have a few, but only a few, flat glass manufacturers. We have a few, but still fewer, producers of technical and laboratory glass. There are some 40 glass container manufacturers. Until recently, we had only one lone producer of fiber glass; now we can count their number on our fingers. Corning, General Electric, Westinghouse, and Sylvania make tubes and lamps. How many make tubing?

And so it goes. What does it all mean? It means, and it is immediately apparent, that for all its tremendous dollar volume (over one billion two hundred and twenty million dollars), the glass industry is really not one industry, but many industries; that each component industry is relatively small numerically; that the common denominator of all is chiefly the material—glass. And even glass, as everyone knows, is a variable as between these industries.

Now let us think of the industry geographically. The geographic concentration or its scatteration is germane to the publishing problem. The geographic problem affects one's ability to get out into the industry and visit with it, and frequent personal contact is a publishing "must." It has an important bearing on whether one can make use of local fact finders, or whether the contact must be maintained from the home office on long, extended (and, incidentally, expensive) trips.

Time was when New Jersey was a glassmaking center. Likewise Pittsburgh. There is a sign in Toledo which proclaims it the glass center of the world. And while Corning has its Glass Center, I am sure Corning does not regard itself as a glass center population-wise. I will not try to argue the point with any of these contestants; but who will quarrel with me when I say that the glass industry has no focal point today, geographically. Rather, the trend, in common with the trend in all industry, is toward decentralization. In terms of atom bombs, labor supply, shipping costs, and many current manufacturing problems, the glass industry can thank its stars that it is no more centralized than it is, even though this does make it tough on the publisher.

I will make only one more analysis; that of occupational responsibility. For example, we have the Top Brass, better known as Management. We have production executives, such as are importantly represented here. We have the scientists and directors of research. We have the technologist and the student, who will be tomorrow's glassman.

All of this is on the domestic scene. Don't forget to take into account the foreign producer. He is by no means to be ignored. The publication I represent has a large percentage of its readership in foreign countries, in every country of the world where glass is produced!

Now, I have made some analyses. What has been their purpose? Only to give you the merest glimpse, a very superficial glimpse, of the many factors that must be taken into account when one publishes for the glass industry.

Earlier in my talk I stressed the importance of advertising and promised to come back to it. The business press is a service industry. Consequently its assets for the most part are intangibles. But like any business, like your business, it costs money to deliver these services. The business press has two sources of income only, subscriptions and advertising.

On subscriptions, the average business paper does well to break even. My publication, as a member of the Associated Business Papers (which you might call the trade association of the business papers), has access to publishing costs for its members nationally. I have studied these and am unable to give you an average profit or loss figure on circulation. The amounts differ widely as between monthlies and weeklies; they differ with the size of the circulation. So I can speak only for myself, though I believe my situation to be typical.

Over any 12-month period, the cost of operating our circulation department has exceeded subscription income substantially. If costs are properly allocated, and include rent, stationery, postage, and all the many elusive factors of subscription procurement, I do not believe any business paper can possibly make a cent off circulation.

It is axiomatic, therefore, that advertising, our only other source of revenue, must carry the load. So in a very large measure, you, the subscriber, and I have to thank the advertiser for whatever we of the press succeed in accomplishing in the line of gathering information and delivering it to you; we have to thank them for what I am proud to describe as a very important tool in business. Remember this very important value when you read his advertisement.

Perhaps what I have said to you may sound like sore arm selling; you may think I feel very sorry for myself and want you to feel sorry for us publishers. I hope you do feel sorry for us. But that has not been my purpose. Sure we have problems, but so do you. And we overcome them, and so do you. But the fact that we do have an able press in the glass industry, considering its many problems—and may I say parenthetically that in the glass industry there are unusual publishing problems not found in many industries—is a great tribute to the ingenuity and resourcefulness of men like Cy Delgado, Jerry Svec, Jay Ebel, and Arthur Kimes.

I have only one more comment to make, and then I am through. Does the business press answer any need? Is it a parasite industry? Does it give full value received? I'll answer these questions with some others.

Is it not significant that not a single industry exists in the United States of any importance but has within it a strong trade press? Is it not significant that nationwide, the strength, vigor, and greatness of any given industry is in direct proportion to the strength of its own business press? Where you have what I may call a "smug" industry—self-satisfied, desiring no free exchange of ideas, indifferent to the service that a good business paper can provide—uniformly and without exception that industry is on the way out! The record shows this to be true. I do not attempt to answer which is the chicken and which is the egg, whether the press is strong because the industry is strong, or whether the reverse, but it is an interesting observation and you need to think about it. I don't think you and I would be far apart in our answers.

I can put this question in still another way: there are two types of companies—and I have had wide experience with them in many different industries. One type is entirely self-sufficient. It has all the know-how. It believes it has more know-how than its competitors. It is not

(*Continued on page* 162)

TWO RECENT REPORTS FROM THE NATIONAL BUREAU OF STANDARDS

CHROMIUM-AND-GLASS HIGH-TEMPERATURE COATINGS FOR MOLYBDENUM

Because of its high melting point (4750°F.), molybdenum offers possibilities for use in aircraft jet engines. If molybdenum is to be used at jet-engine temperatures, however, it must be protected from rapid oxidation.

The National Bureau of Standards has recently conducted a study of protective coatings for molybdenum composed of chromium and frit (glass). Results indicate that such coatings greatly extend the useful life of molybdenum at high temperatures, giving better protection than either chromium or ceramic coatings alone. Various chromium-frit coatings were bonded to molybdenum specimens, then subjected to oxidation tests under tension in the range 1500° to 1800°F. and to flame tests in the range 2000° to 3000°F. At temperatures of 1500° to 1800°F. the coated specimens lasted for 1000 to 3000 hours. At 2800°F., with no applied load, protection for as much as 7 hours was attained, enough to be valuable for some applications. The investigation was conducted by D. G. Moore and associates of the NBS enameled metals laboratory, under the sponsorship of the National Advisory Committee for Aeronautics.[1]

The present NBS study is one phase of a continuing program for development of ceramic protective coatings for metals and alloys. This NACA-sponsored program has resulted in several successful NBS coating formulations that are now in regular commercial production.

[1]This NBS study is reported in detail in "Study of Chromium-Frit-Type Coating for High-Temperature Protection of Molybdenum", by D. G. Moore, L. H. Bolz, J. W. Pitts, and W. N. Harrison, NACA Technical Note 2422 (July 1951).

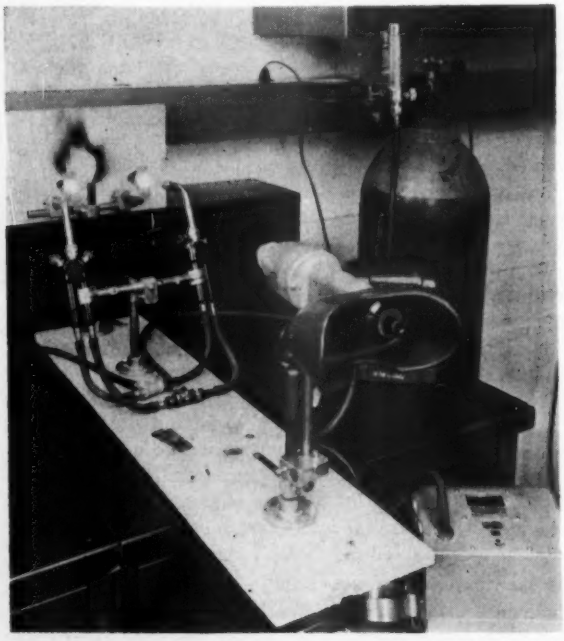


Fig. 1. Apparatus for flame-testing coated molybdenum specimens at the National Bureau of Standards. Specimen surface temperatures, which ranged from 2000° to 3000°F, were observed by means of an optical pyrometer (right of center). Chromium-frit coatings were found to add substantially to the life of the molybdenum.

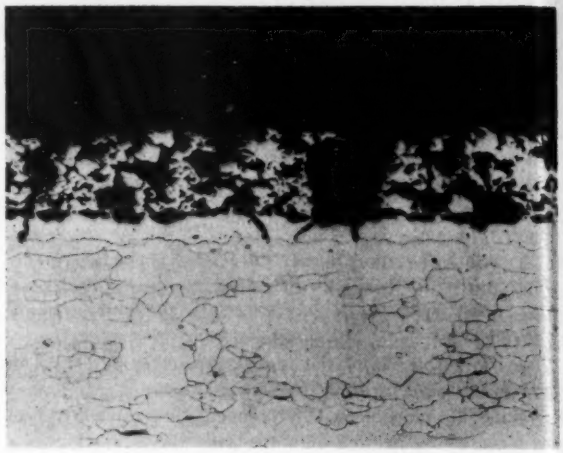


Fig. 2. Photomicrograph of molybdenum specimen coated with glass seal-coat M-13 on top of chromium-frit coating M-39. The specimen was subjected to thermal shock for 25 cycles from 1800°F, prior to sectioning. The glass seal-coat apparently tended to seal thermal-shock cracks that developed in the base coat. Top (dark gray) layer: plastic mount. Second (narrow black) layer: glass seal-coat. Third (variegated gray-and-white) layer: chromium-frit coating. Fourth (narrow white) layer: diffusion layer. Bottom (near-white) layer: molybdenum. (X150, etched in nitric acid).

In this new study, molybdenum specimens were first coated with one of several powdered chromium-bearing base coats, which in some cases also contained some frit (glass). After firing of the base coat, in either a hydrogen or an argon atmosphere, a ceramic seal-coat containing no chromium was applied to some of the specimens. Test results indicate that the most durable coatings resulted from application of a glass-free chromium base coat, followed by a glass seal coat. Addition of a third coat, consisting of lower-melting glass, resulted in a coating showing the highest durability of all those investigated.

Microscopic examination of sections shows that the chromium of the base coat has a somewhat porous structure, formed by the diffusion-welding of the chromium particles to each other and to the molybdenum base. The glass is subsequently absorbed into this structure during the firing of the seal coat. Although thermal strain and rapid creep tend to cause cracking of the coating, adherence is excellent and the glassy layer tends to reseal the fissures so that cracking does not result in rapid failure.

CARD CATALOGUE OF INFRARED SPECTRA

A comprehensive punch-card catalogue of all available data on the infrared spectra of organic and inorganic compounds is being set up by the National Bureau of Standards under the sponsorship of the National Research Council. The card catalogue not only fills the pressing need for a general reference library of infrared spectra but also provides a survey of the literature on each compound and abstracts of the papers covered. The task of compilation is now well under way, and the first

(*Continued on page* 164)

Inventions and Inventors

Furnaces

Siliceous Refractory Material. Patent No. 2,617,736. Filed December 29, 1947. Issued November 11, 1952. No drawings. Pietro Ciferri.

An industrial process is described for the production of refractory materials from natural materials containing about 98% silica. Dinas stone, ganister, or quartz sand is ground by a heavy and rapid crusher with about 25-35% of water without the presence of binding material. The grinding time is about four hours during which a very sticky mud is formed which is said to amalgamate. If the mud is allowed to "season" for approximately one month according to the ambient conditions, the amalgamating process continues while the water percentage diminishes. "If the resulting paste is heated gradually (at 1000-1500°C.), it may reach the highest temperature, that is to the fusion point, without decomposition." This phenomena is claimed to be absolutely new and novel and thus these quartz products can be made without the aid of any binding material and thus are more refractory. Various refractory products are suggested.

The patent contains five claims and the references cited were: 136,083, McAninch et al., Feb. 18, 1873; 202,637, Earnshaw, Apr. 23, 1878; 439,796, Bottome, Nov. 4, 1890; 701,707, Gibson, June 3, 1902; 1,791,591, Caven, Feb. 10, 1931; 122,388, Great Britain, 1919; and Searle: *Refractory Materials*, 1924, page 101.

Stirrers for Molten Glass. Fig. 1. Patent No. 2,617,636. Filed January 10, 1950. Issued November 11, 1952. Two sheets of drawings. Assigned to Emhart Manufacturing Co. by Edward T. Ross.

This invention is an improvement in the stirrer used in the typical forehearth. The stirrers are easily moved up and down and are readily replaced.

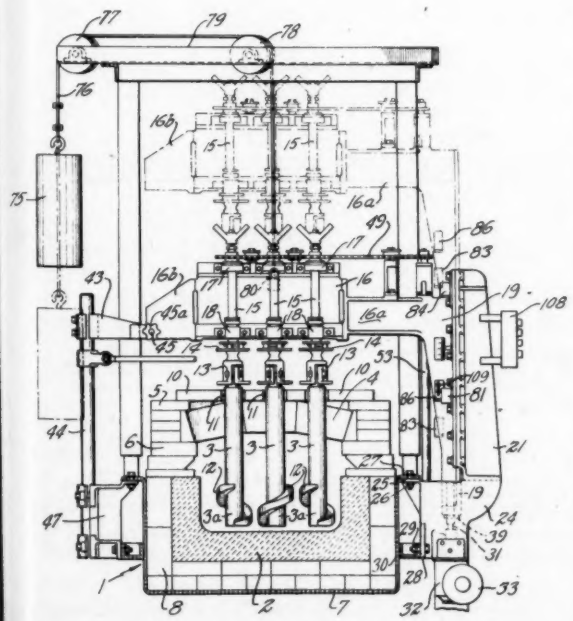


Fig. 1.

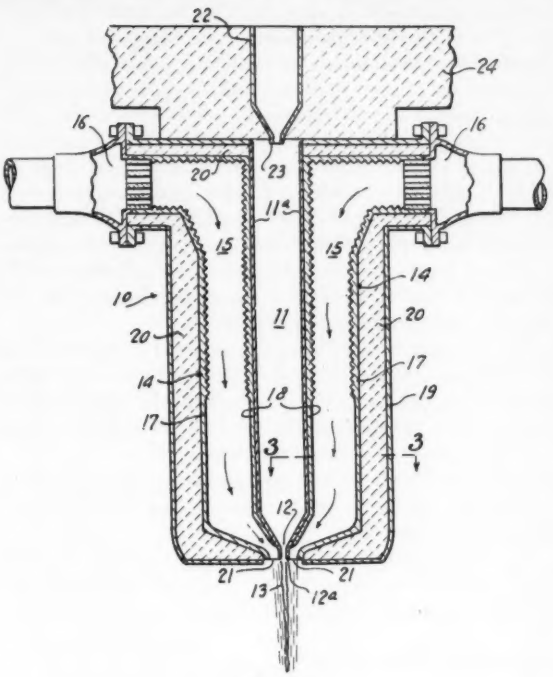


Fig. 2.

The operation of the stirrers is best understood in referring to Fig. 1. The glass stirrers 3 extend through a gap 4 in the roof 5 of a cover structure 6 of the forehearth. The lower part of the stirrer 3a that engages the molten glass contains spiral projections 12 which greatly facilitate stirring action.

The channel 2 is contained in a metal casing 7 and insulated by insulation 8. Raising and lowering of the arm 16, as well as the stirrers, is facilitated by a counterweight 75 suspended from the cable 76. The upward and downward movements of the stirrer are controlled by the reversible elevating motor 33. When the stirrers are in their working position down in the forehearth channel, the stirring operation is accomplished through motor 61 (not shown). The entire operation is flexible and automatic and provides good control and easy replacement of stirrer parts.

The patent contains four claims and the references cited were: 169,047, Schofield, Oct. 19, 1875; 1,025,396, Hasbur, May 7, 1912; 1,488,941, Roxs, Apr. 1, 1924; 2,238,-800, Mueller, Apr. 15, 1942; 2,304,772, Allardice et al., Dec. 15, 1942; 2,372,862, Strauss et al., Apr. 3, 1945; and 2,467,809, Cannon et al., Apr. 19, 1949.

Glass Wool and Fiber

Glass Fibers. Fig. 2. Patent No. 2,626,484. Filed March 18, 1946. Issued January 27, 1953. Two sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego.

The primary object of this invention is to provide a fiber forming apparatus of small volume that employs a high temperature gaseous blast that will melt and attenuate the molten glass into fibers.

The apparatus shown in Fig. 2 is composed of an elongated melting chamber 11. The lower end of the chamber 11 is formed with a plurality of restricted discharge orifices 12 formed in depending tips or nipples 12a through which molten glass flows in the form of streams 13. The walls 11a of the chamber are formed of material capable of withstanding extremely high temperatures over long periods of use. Platinum and, in some cases, molybdenum have given exceptionally good service. On each side of the chamber 11 is a burner 14 and each burner comprises a combustion chamber 15. The inner walls 18 of the combustion chambers form a heat resistant covering for the metal walls of the glass chamber 11 and protect the latter walls from direct contact with the flames produced by the burners. However, the refractory walls 18 embrace the metal walls of the glass chamber 11 and may be considered a part of the latter.

Molten glass may be introduced into the upper end of the chamber by a feeder 22 supported above the fiber forming equipment 10. The velocity of the blast at 21 is so great that the streams issuing from the orifices 12 are attenuated into extremely fine fibers.

Many modifications and adaptations of the equipment are possible and can be appreciated only after a study of the many drawings.

The patent contains 11 claims and the references cited were: 2,489,242, Slayter et al., Nov. 22, 1949; and 2,515,738, Slayter et al., July 18, 1950.

Sheet and Plate Glass

Window Construction. Fig. 3. Patent No. 2,617,482. Filed January 30, 1950. Issued November 11, 1952. One sheet of drawings. Carl J. Wagner, inventor.

A very handy window construction is shown that permits the use of an outward window frame and inner screen and at the same time allows ventilation and provides a water-tight seal. In Fig. 3 A is a stationary window frame of a cross-section having a portion A^1 for overlapping the outer face of the wall surrounding the window opening, an inwardly extending portion A^2, a portion A^3 in an inner plane parallel to the portion A^1 and a return bend portion A^4 to which the screen B is attached. The portion A^1 is preferably of a slight concavo-convex form so that its outer margin will be pressed against the wall to form a sealing joint therewith. F is a ventilator sash connected to frame A by a hinge F^1 (not shown) extending along one edge. Water collecting in the convex drainage channel A^1 is permitted to drain off through the perforations G made at several points.

The patent contains three claims and 10 references were cited.

Storm Windows. Patent No. 2, 618,818. Filed February 15, 1946. Issued November 25, 1952. One sheet of drawings (none reproduced). Joseph Kublanow, inventor.

This invention relates to new and useful improvements in storm window construction. Auxiliary window structure is provided by sash frames that are mounted in sliding engagement with sealer frames. The aperture frames are self-sealing and require no caulking after mounting in place. The patent is best understood by a study of the various drawings.

The patent contains one claim and ten references were cited.

Multiple Glazing of Windows. Fig. 4. Patent No. 2,624,978. Filed December 28, 1948. Issued January 13, 1953. Four sheets of drawings. Assigned to the Pittsburgh Plate Glass Co. by Frederick R. Hohmann.

This invention involves an improved method of construction for making multiple glazed units by welding spaced sheets at their margins to provide a hermetically sealed unit. The plates are prepared for welding by applying stripes of conducting material such as colloidal graphite or "Nesa" stripes by spraying tin chloride solution against hot glass.

The welding is accomplished by the apparatus shown in Fig. 4.

This apparatus includes a furnace 14 having three

Fig. 3.

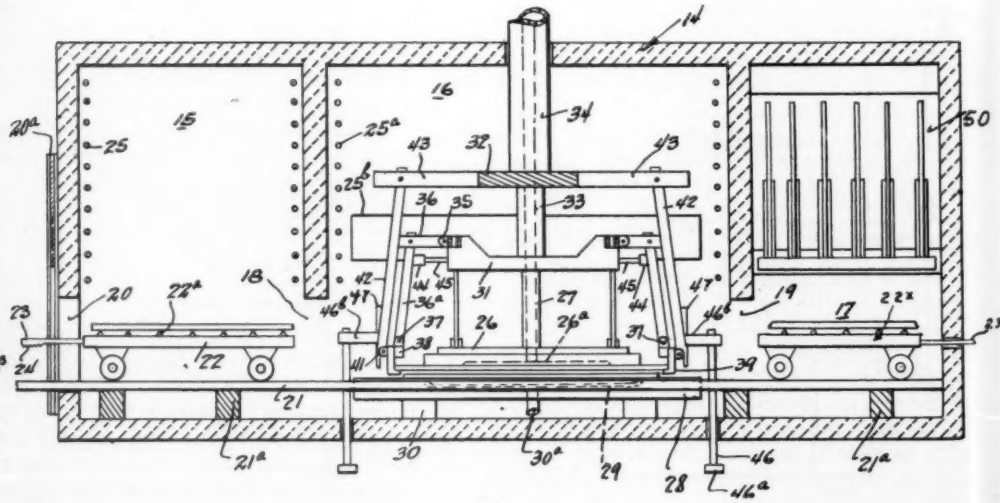


Fig. 4.

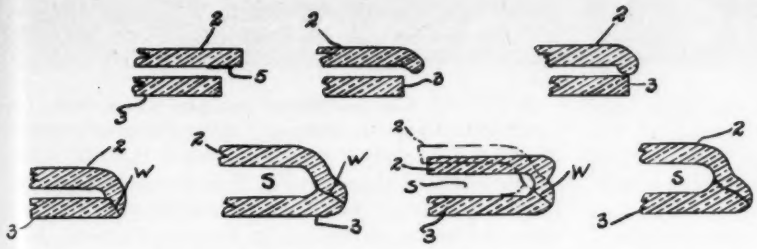


Fig. 5.
Left to right: Top, Cycles 1-3;
Bottom, Cycles 4-7.

chambers 15, 16, and 17 which are respectively a preheating chamber, a welding chamber, and an annealing lehr. A trackway 21 on supports 21a extends through the openings or doors and is designed for transferring car 22 that carries the plates of glass into chamber 15, then to chamber 16. The car 22 is operated by means of a ram or bar 23. A similar car 22x functions to carry the hot but welded units to chamber 17 for annealing.

Plates of glass supported on buttons 22a on car 22 are maintained in this chamber until the glass has passed above the critical temperature, which is about 800-1000°F.

The apparatus for welding and shaping the units includes an upper platen 26 and a lower platen 28 upon which the plate rests. The electrode mechanism includes rotatable shafts or arms 46 extending upwardly through the bottom of chamber 16. After the plates are welded together at the margins, they are spaced or separated by refractory vacuum cups applied to the upper and lower sheets of glass. These vacuum cups are then moved apart to effect separation of the plates.

The patent contains four claims and the following references were cited: 2,149,246, Zimmerman et al., Feb. 28, 1939; 2,303,125, Knight, Nov. 24, 1942; 2,389,360, Guyer et al., Nov. 20, 1945; 2,398,371, Gerspacher, Apr. 16, 1946; and 2,478,812, Drake, Aug. 9, 1949.

Welded Double Glazed Units. Fig. 5. Patent No. 2,624,979. Filed December 28, 1948. Issued January 13, 1953. Five sheets of drawings. Assigned to the Pittsburgh Corning Corporation by William R. Clever and Harry O. Phalin.

The welding of double glazed units at their margins is described and the process and equipment used is similar to that indicated in Patent No. 2,624,978. The various cycles of welding are best shown in Fig. 5. Heat is applied to the electrical coating S by suitable electrodes (not shown). At the end of the 2nd cycle, the sheet is shown to have sagged considerably. The cycles 3 to 7 illustrate the effects of increased heat that are needed to abut portions of sheets 2 and 3 to a suitable weld. For practical purpose, sheet 3 is held fast and sheet 2 is slowly withdrawn to start the formation of a fillet.

During the withdrawal of sheet 2 from sheet 3, air rushes into the space S between the sheets through the pore hole P and prevents formation of a vacuum which would collapse the softened glass at the weld.

During the described withdrawing operation and filling of space S with air, the glass in the weld has cooled sufficiently to be self-supporting, but is still soft enough to be pliable. Sheet 2 is now quickly pushed downward toward sheet 3 about one-half the distance between the sheets. This rapid reduction of the space between the sheets compresses the air in space S and the resultant increased air pressure evenly rounds out the fillets at the weld into substantially one continuous fillet. Sheet 2 is then withdrawn again to provide the required final spacing between the sheets and without material deformation of the fillets.

The unit may now be removed to a suitable annealing chamber and slowly brought to room temperature.

The patent contains 22 claims and the references cited were: 2,282,831, Shutts, May 12, 1942; 2,336,544, Hopfield, Dec. 14, 1943; 2,389,360, Guyer et al., Nov. 20, 1945; 2,398,371, Gerspacher, Apr. 16, 1946; and 2,419,400, Haven, Apr. 22, 1947.

Miscellaneous Processes

Glass Fabrication. Patent No. 2,620,598. Filed April 20, 1948. Issued December 9, 1952. One sheet of drawings, none reproduced. Assigned to James A. Jobling and Company Limited by Joseph A. Jobling—Purser, Shaun Maturin Cox, Peter Linley Kirby, and Kenneth Alexander Murdoch.

A method of fabricating various articles of borosilicate glass is described. A thin film of boric oxide about 0.1 mm. or less is formed on the surface of the pieces to be used. The film is best formed by spraying with an ester of boric acid, e.g. 25% solution of n-prophyl borate in anhydrous methyl alcohol. The film is allowed to hydrolyze in slightly humid air and then the desired shapes are laid together and heated for 17 hrs. at 800°C. The procedure is not only applicable to performed components, but to components that are to be formed by the sintering methods as well.

The patent contains five claims and the following references were cited: 519,186, Hughes, May 1, 1894; 1,565,598, Sproesser, Dec. 15, 1925; 2,065,852, Dalton et al., Dec. 29, 1936; 2,238,777, Lemmers et al., Apr. 15, 1941; and 455,460, Great Britain, Oct. 21, 1936.

Mercury Filled Lamps. Fig. 6. Patent No. 2,615,472. Filed December 16, 1947. Issued October 28, 1952. One sheet of drawings. Assigned to General Electric Company by Marvin Pipkin.

In connection with the manufacture of electric discharge lamps or fluorescent lamps, the introduction of a specific measured amount of mercury is difficult to accomplish. Fig. 6 illustrates an exhaust tube 7 provided with an interior coating 10 with a stem 2, leading-in wires 5, 6, and electrode 4 to form a complete stem mount. This stem mount is then sealed to an end of the lamp envelope 1, the other end of which is sealed by a similar stem mount which, however, may or may not be provided with a residue of exhaust tubing. After evacuation of the lamp envelope, but while it is still in the exhaust machine, the desired quantity of mercury is fed or dropped through the exhaust tube 1, as shown by the arrow in the drawing, into the lamp envelope 1. The exhaust tube is then sealed or tipped-off adjacent to the stem seal portion 3 to

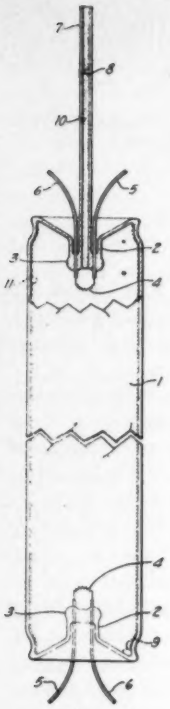


Fig. 6.

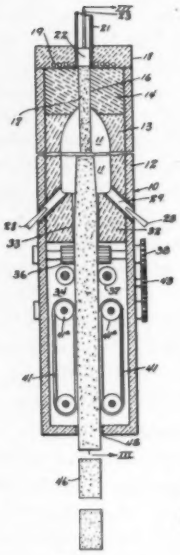


Fig. 7.

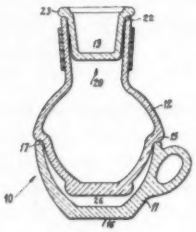


Fig. 8.

thereby hermetically seal the lamp envelope. The envelope is then provided at each end with suitable bases having contact terminals, to which terminals the electrode lead-in wires 5, 6 are connected.

The patent contains two claims and 15 references were cited.

Cellular Glass. Fig. 7. Patent No. 2,620,597. Filed April 9, 1947. Issued December 9, 1952. Two sheets of drawings. Assigned to Pittsburgh Corning Corporation by Walter D. Ford.

A process for producing cellular glass is shown which eliminates the necessity of using refractory molds, as well as expensive conveyors and the high costs of labor involved in maintaining and handling such equipment.

A vertical furnace 10 is shown in Fig. 7. It consists of a cellulating chamber 11 and outer jacket 12 which insulates the refractory material 13. The upper portion of the furnace is provided with a die 14 and opening 16.

In order to feed compacted material through the die 14 into the furnace, a conduit or cylinder 21 of steel is properly aligned with the die opening. Material to be cellulated is fed into the conduit 21 by means of ram 22. Appropriate rolling mechanism 36 of refractory material engages the cellular mass as it leaves the furnace and serves as a means of removing the column of material from the furnace.

In operation of the apparatus, various materials may be employed such as pulverized glass or mixtures of pulverized glass blast furnace slag, feldspar, aplite, clays, and shales. If pulverized glass is employed, small amounts of an appropriate gassing agent like calcium carbonate, carbon black, or powdered coal should be used. Careful control of temperature of the furnace is demanded and uniformity of flow of the column 17 through the die is highly desirable. Short stoppages are necessary for the introduction of additional charges of the raw material.

The patent contains one claim and 14 references were cited.

Bottle and Cup Combination. Fig. 8. Patent No. 2,619,245. Filed November 5, 1949. Issued November 25, 1952. One sheet of drawings. Melvin H. Levi.

The invention shown in Fig. 8 is a combination cup, bottle, and creamer which may be assembled in compact form and easily carried, as in hotels, restaurants, hospitals, and dining cars. The assembly shown in Fig. 8 indicates a cup 10, a bottle 12, and stopper 13 for cream or other foodstuff. The assembled unit not only provides loss of handling, but enables liquids to be kept warm or cold as desired.

The patent contains one claim and 15 references were cited.

Sight Glass. Fig. 9. Patent No. 2,620,662. Filed May 29, 1950. Issued December 9, 1952. One sheet of drawings. Assigned to Worthington Corporation by R. M. Henderson.

A strong, sturdy construction for a non-breakable water sight glass is shown in Fig. 9. The gauge is particularly adaptable to an opaque enclosed tank. The tank 1 is made of metal and the outer portion of one wall is bent in order to provide a protecting channel for the glass gauge. A transparent sight glass 5 is mounted over the outer open side of the channel 3 and is attached in fluid light engagement to the wall 2 to prevent leakage of water from the channel by a gasket 8, scale plate 9, and suitable bolts 10. The scale plate 9 and the gasket 8 are provided with longitudinal openings so that the level of the water or other liquid in the channel 3 will be visible through the transparent sight plate 5.

The patent contains three claims and the following references were cited: 222,263, Fitzgerald et al., Dec. 2, 1879; 268,186, Cave, Nov. 28, 1882; 406,176, Mayer, July 2, 1889; 1,347,398, O'Rourke, July 20, 1920; 1,377,577, Hanson, May 10, 1921; and 1,784,973, Preston, Dec. 16 1930.

Fluorescent Coating. Patent No. 2,619,472. Filed May 2, 1950. Issued November 25, 1952. No drawings. Assigned to General Electric Company by Herman R. Schoenfeldt.

An improved fluorescent coating for electric discharge lamps is given. Halophosphate phosphors are made to adhere firmly to a glass surface by a preliminary treatment.

As an example of the process, the powdered phosphor, of calcium chloro-fluoro-phosphate activated with antimony and manganese, is mixed with .7 per cent by weight of boric acid. The dry mixture is milled for about one-half hour and then fired in a covered silica tray at a temperature of about 900°C. for two hours. Subsequently, the treated phosphor is suspended in a solution of nitrocellulose in amyl acetate. A coating of

(*Continued on page* 165)

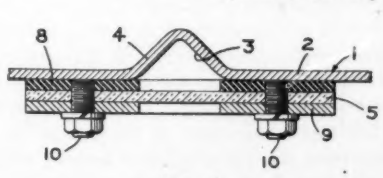


Fig. 9.

The Influence of Founding Time and Temperature on the Fluorine Content of an Opal Glass

In the October 1952 issue of the *Journal of the Society of Glass Technology*, R. J. Callow and G. Lawson report the results of an investigation designed to study the influence of founding conditions on the loss of fluorine from an opal glass.

This work was designed on a factorial basis and three factors were considered: (1) founding time, (2) founding temperature, and (3) amount of fluorine added. Each of these was investigated at three levels. This meant that twenty-seven separate melts were needed to complete the whole experiment. Because of this, it was not found possible to carry out a repetition. Despite the limited intention of the experiment, the results proved to be of considerable interest.

The different melts were based on a glass of the following weight percentage composition: SiO_2 71, Na_2O 17, CaO 6, ZnO 6. Batches were calculated on 800 gm. of the base glass, 4, 7, or 10 parts by weight of fluorine being added (as sodium silicofluoride) for every hundred parts of the other elements calculated as oxides. Necessary adjustments were made to keep the silicon and sodium constant. The batches were melted in platinum crucibles, founding temperatures being 1350°, 1400°, and 1450°. When the founding temperature was reached, it was kept constant for the melting time of 4, 16, or 24 hours. The glass, after casting and rolling, was annealed at 600°. Samples were selected at random from the annealed plate and used for the determination of specific gravity (four samples), fluorine content, and refractive index. The specific gravity was determined by the usual Archimedes method; the refractive index by means of an Abbé refractometer. In some cases, extremely variable results were obtained at different points on the refractive-index sample. Results from these samples were discarded. The white light transmission was also measured on a few samples using an opacimeter.

The analysis of variance of the fluorine contents showed that the founding temperature affected the fluorine content, while there was an interaction between the two remaining factors. Table I gives the average fluorine content for each founding temperature and shows that the principal effect occurs above 1400°. The analysis of variance at each level of fluorine in the batch and at each level of time of founding show that the effect of founding time is significant only in those melts with 10 parts per hundred of added fluorine, while the effect of added fluorine is significant only for the shortest founding time. Table II shows the averages for each amount of added fluorine at each founding time, and clearly reveals the conclusions of the analyses. In those melts with 10 parts per hundred of added fluorine, increase of founding time from 4 to 16 hours results in a sharp drop in the fluorine content, but a further increase to 24 hours has no effect. At the other levels of added fluorine, the founding time does not reduce the fluorine content sufficiently to give a significant result in the analysis of variance. It is probably safe to conclude, however, that, here also, increase of founding time from 4 to 16 hours reduces the fluorine content but that further increase has only a negligible effect. The amount of fluorine added in the batch influences the final fluorine content only of the glass at the shortest founding time.

TABLE I

Founding Temp. °C.	Average Fluorine Content %
1350	3.5
1400	3.2
1450	2.4

TABLE II

Time in Founding in Hours	*Fluorine in Batch (parts/hundred)* 4	7	10	
4	3.3%	3.9%	5.3%	Fluorine in Glass
16	2.8	2.8	2.0	
24	2.1	2.6	2.4	

These observations indicate that there is an equilibrium concentration of fluorine in the melt, appropriate to and dependent upon the temperature. Prolonged heating has little effect on this amount, which is not sufficient to produce opalescence on cooling. Establishing the equilibrium concentrations takes between 4 and 16 hours, the time being substantially independent of the amount of fluorine in the batch within the range of this experiment. When the equilibrium concentration has been established, the amount of fluorine initially in the batch is immaterial. However, for times of founding too short to achieve the equilibrium concentration, the amount of fluorine retained is a function of the amount in the batch.

It has been previously suggested by R. J. Callow that the process of bringing the batch to the founding temperature resulted in a loss of fluorine directly proportional to the amount present in the batch. Once the batch has melted, however, fluorine continues to be lost until the correct equilibrium content is achieved. Although, of course, the loss continues on further heating in an open container, the rate is very slow. This shows that the vapor pressure of fluorine above a melt containing the equilibrium concentration is very low. Melts containing larger amounts of fluorine must have a much higher vapor pressure of the gas. They appear, however, to be quite homogeneous at temperatures above 1000°. Certainly, if excessive fluorine is added in the batch, silica aggregates will occur in a very fluid melt and the solution of the silica will be accompanied by a rapid fluorine loss Nevertheless, in the present case, no undissolved material was present after one hour's founding, and there was nothing to indicate inhomogeneity. This suggests the possibility that fluorine may be present in such a melt in two forms. One of these would be a combination with the major structural units, so that fluorine removal requires the disruption of large units, leading to a low fluorine vapor pressure. The other would be an interstitial or ionic form,

(*Continued on page* 166)

G.C.M.I. SPRING MEETING

The Board of Trustees of the Glass Container Manufacturers Institute has announced that the 1953 Spring Meeting will be held at The Greenbrier, White Sulphur Springs, West Virginia, on May 18, 19, and 20.

The purpose of the meeting will be to provide an opportunity for the Board of Trustees to receive semi-annual reports from the nine standing committees and to make the same available to the membership; to hold the Annual Membership Meeting for, among other things, the election of four Trustees to serve a three-year term.

Arrangements have been made for two outside speakers. One will cover "The General Business Outlook with Special Reference to the Glass Container Industry," and the other will speak on "Selling to Defend America."

THATCHER ELECTS DAVID PARFITT TO BOARD

The Board of Directors of Thatcher Glass Manufacturing Company, Inc., has announced the election of David R. Parfitt to the Board. Mr. Parfitt, Vice President and General Sales Manager of the company, will fill the vacancy that existed due to the recent death of Jervis Langdon.

Mr. Parfitt, who has been with Thatcher for 30 years, represents the company as a member of the Customer Relations Committee, Dairy Industries Suppliers Association, and the Design and Specifications Committee of the Glass Container Manufacturers Institute.

The Board also announced the resignation of W. A. Wood as Vice President of the company.

STEUBEN CRYSTAL FEATURED IN TRAVELING EXHIBITION

Steuben Glass has assembled a traveling exhibition of approximately 160 designs in crystal to be shown in leading museums on the West Coast during the Spring and Summer of 1953. The exhibition opens April 16 in the Fine Arts Gallery of San Diego, California, and will be shown subsequently at the Santa Barbara Museum of Art, the San Francisco Museum of Art, and the Portland Art Museum.

The exhibition will include examples of engraved glass designed by such contemporary artists as Henri Matisse, Sidney Waugh, and Salvador Dali. It will introduce for the first time a group of engraved pieces designed by the American sculptor, Bruce Moore, and the work in glass of five leading British artists: Robin Darwin, Jacob Epstein, Graham Sutherland, Frank Dobson, and Matthew Smith. Advanced, experimental work in blown and hand-fashioned glass forms will be shown in the exhibit, as well as some of the noted Steuben designs.

• Establishment of its Central Division sales headquarters at Hammond, Indiana, has been announced by the Chemical Division of Kaiser Aluminum & Chemical Sales, Inc. The new office is located in the Calumet National Bank Building with R. L. Petersen as Division Sales Manager.

GLASS DIVISION SYMPOSIUM

The Glass Division of the American Ceramic Society will sponsor a Symposium on Annealing Glass at State College, Pa., on June 8, 1953. The Symposium will be of an off-the-record nature and invitations may be obtained from N. M. Brandt, Mellon Institute, Pittsburgh 13, Pa.

MANAGEMENT AWARD GIVEN TO SIX GLASS COMPANIES

Six glass companies have been awarded Certificates of Management Excellence for the year 1952 by the American Institute of Management in New York City. Those so designated include Anchor Hocking Glass Corporation, Corning Glass Works, Hazel-Atlas Glass Company, Libbey-Owens-Ford Glass Company, and Owens-Illinois Glass Company. All obtained the award for the third consecutive year.

According to Jackson Martindell, President of the Institute, only 330 companies in the United States and Canada out of the 3,000 leading concerns whose methods were studied by the Institute were found eligible to receive the award.

In order to qualify, a company must be given 7,500 points out of a possible 10,000. These credits are assigned for excellence in ten separate areas of management: economic function, corporate structure, health of earnings growth, fairness to stockholders, research and development, directorate analysis, fiscal policies, production efficiency, sales vigor, and executive evaluation.

IOWA UNIVERSITY TO HOLD MANAGEMENT COURSE

The College of Engineering, State University of Iowa, has announced the fourteenth Summer Management Course to be held June 15 through June 27, 1953 in Iowa City. It is an intensive course for factory managers, foremen, industrial engineers, methods and time-study analysts, cost accountants, and office executives.

The areas of Production Planning, Job Evaluation, Motion and Time Study, Wage Incentives, Plant Layout, Materials Handling, Quality Control, Supervisory Training, Labor Relations and Legislation, Organization and Policy, and Public Speaking are included.

MINNEAPOLIS-HONEYWELL APPOINTMENTS

Devon W. Fryback has been named Sales Manager of the Eastern region for the Industrial Division of Minneapolis-Honeywell Regulator Company, according to an announcement by C. L. Peterson, General Sales Manager. Mr. Fryback joined the firm in 1927 and worked in the company's Chicago, New York, and Connecticut territories. He was industrial manager in Hartford and branch manager in Albany.

At the same time, it was announced that O. B. Pyle, Jr., has been appointed Industrial Manager of the Mid-Atlantic area and Edward J. Klein as Industrial Manager for the firm's Philadelphia branch office.

Announcement was also made of the appointment of J. A. Robinson as Field Sales Manager for the Industrial Division. Mr. Robinson joined the firm in 1929 and in 1949 was appointed Industrial Manager for the Midwest region. He was made Industrial Manager for the Eastern and Mid-Atlantic regions in May 1952.

Current Statistical Position of Glass

Employment and payrolls: During December 1952, employment in the glass industry dropped from the adjusted November employment figure of 135,200 persons to reach a preliminary 134,700. This is a drop of only .3 per cent. During December 1951, employment was 123,100 which is 9.4 per cent below December 1952.

Payrolls in the glass industry during December 1952 were a preliminary $43,602,390. This represents a rise of 1 per cent over the previous month's adjusted payrolls of $43,002,590. During December 1951, payrolls were $35,878,726, which is 21.5 per cent below December 1952.

Glass container production, based on figures released by the Bureau of Census, opened the year with a figure of 9,292,650 gross. This is 12.3 per cent above the 8,250,347 gross produced during December 1952. During January 1952, production was 8,903,457 gross, which is 4.3 per cent less than for January this year.

Shipments of glass containers also rose during January 1953 and were reported at 8,836,534 gross. During December 1952, shipments were 8,115,977 gross, representing a January gain of 8.8 per cent. During January 1952, shipments of glass containers were 8,661,699 gross, or 2 per cent less than shipped during January this year.

Stocks on hand at the close of January 1953 were 10,427,036 gross. This is 2.5 per cent higher than the 10,166,279 gross on hand at the end of December 1952 and 8.6 per cent higher than the 9,599,162 gross on hand at the end of January 1952.

Due to a delay in the compilation of figures showing the production, shipment, and stocks of automatic tumbler ware and manufacturers' sales of machine-made table, kitchen, and household glassware for January 1953, THE GLASS INDUSTRY is unable to publish these statistics in this issue. It is planned to include these data in this department in the April 1953 issue.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

	January, 1953
Narrow Neck Containers	
Foods	862,240
Medicinal & Health Supplies	1,185,091
Chemicals, Household & Industrial	669,949
Beverages, Returnable	353,911
Beverages, Non-returnable	30,590
Beer, Returnable	115,262
Beer, Non-returnable	420,000
Liquors	602,689
Wines	308,452
Toiletries & Cosmetics	614,892
Sub-total (Narrow)	5,163,076
Wide Mouth Containers	
Foods	*2,303,622
Dairy Products	259,640
Medicinal & Health Supplies	409,515
Chemicals, Household & Industrial	138,334
Toiletries & Cosmetics	146,170
Packers' Tumblers	181,582
Sub-total (Wide)	3,438,863
Total Domestic	8,601,939
Export Shipments	234,595
TOTAL SHIPMENTS	8,836,534

* This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production January 1953	Stocks January 1953
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,602,521	3,650,372
	Wide Mouth	*2,973,727	*3,259,944
Dairy Products		307,172	344,302
Beverages, Returnable		565,637	931,448
Beverages, Non-returnable		37,557	94,047
Beer, Returnable		195,337	235,618
Beer, Non-returnable		466,286	436,361
Liquors		658,202	916,408
Wines		318,671	423,529
Packers' Tumblers		167,540	135,007
TOTAL		9,292,650	10,427,036

* This figure includes Home Canning.

FOXBORO EXTENDS MONTREAL FACILITIES

A new plant extension by The Foxboro Company, Ltd., at Montreal has more than doubled its instrument manufacturing facilities in Canada, according to a recent announcement. The recent expansion is the second one in the past five years.

The new section adds 23,000 square feet of factory space for the production of instrument parts, assembly of instrument panels and cabinets, storage of materials, and for enlargement of the plating, finishing, and shipping departments. An additional 5,000 square feet on a lower level provides a new cafeteria for employees and training school facilities.

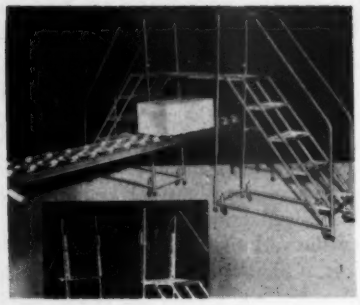
PANGBORN NAMES DISTRICT MANAGER

John C. Pangborn, Jr., has been appointed Hagerstown District Sales Manager of the Pangborn Corporation, according to a recent announcement.

Mr. Pangborn's promotion follows years of experience in the blast cleaning and dust control fields. He has served in many capacities in the office and shop, learning all phases of the business. Since returning from duty with OSS in World War II, he has served as an erector of Pangborn machines, as Manager of the Erecting and Service Division, as sales engineer in Detroit, and for more than a year was Pangborn's representative in Boston. From 1951 until his recent promotion, he has served as Expeditor and Assistant Head of Department in Purchasing.

• Alexander Brassers has acquired a controlling interest in Furnace Engineers, Inc. Furnace Engineers will be operated as an associated company of The Brassers Corporation, Niles Construction Company, and Standard Boiler & Plate Iron Company.

New Equipment and Supplies



CONVEYOR WALK-OVER

Ballymore Company, Wayne, Pa., has announced a new conveyor walk-over which is provided by dual Ballymore safety step ladders equipped with a connecting walkway. The walkway can be folded up so that the ladders may be used for normal requirements when not needed to cross over conveyors.

Standard size ladders are available for almost any required height. Built of steel, the ladders are available in two types. One has rubber tipped legs only for permanent or semi-permanent installations. The other is equipped also with casters for easy movement. These casters automatically retract when a person steps on the ladder so that the rubber tipped legs firmly engage the floor.

NEW DOUBLE-BOOM ADJUSTOVEYOR

The Stewart-Glapat Corporation, Zanesville, Ohio, has announced manufacture of a new double-boom Adjustoveyor. The unit is designed for heavy-duty applications requiring heavy load carrying capacities, and features the increasing of its open length 220% over its closed length.

The double-boom Adjustoveyor will assume countless different positions and lengths, and is completely counterbalanced for ease of handling. Construction features heavy truss design, to carry loads of 50 to 100 pounds per linear foot, depending on the model. The power-operated double-boom will carry full loads over its entire length, even when completely extended.

Models are available from 8′ to 25′ closed, and from 16′ to 61′ open, and can be operated at any boom extension distance in between. Length of the boom extension can be varied at will, with operating in-out buttons at each end of the Adjustoveyor. The unit is available with fixed height legs, or adjustable legs that will allow elevations for stacking up to 30°. Belt speeds are variable, either forward or reverse.

NEW TYPE HI-TEMP OIL

E. F. Houghton & Company, 303 W. Lehigh Avenue, Philadelphia 33, Pa., has announced a new lubricant for use at temperatures of 500° and over, known as Hi-Temp Oil 303, which is light enough to be fogged easily in automatic lubricators yet provides high load carrying protection.

This recently developed "hot-spot" lubricant combines molybdenum disulphide with a synthetic base and a pure, low-carbon-content petroleum oil. These properties impart exceptional lubricity, high resistance to heat breakdown, and reduce carbon build-up to a minimum on bearings exposed to elevated temperatures. The lubricant will not separate in storage, according to the manufacturer, making it particularly well suited for automatic spray or mist dispensing equipment.

CATALOGS RECEIVED

Minneapolis-Honeywell Regulator Company, Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa., has made available a new 2-page specification sheet, No. 115, which describes indicating pyrometers, resistance thermometers, and tachometers of the high resistance millivoltmeter type. Construction and engineering details are included.

The company has also published a set of seven new specification sheets in consolidated style covering its flow meter line. Specification sheets 241 and 242 cover electric evenly graduated flow meter bodies and mechanical evenly graduated flow meters, respectively. Sheets 243 through 247 cover square root flow meters and liquid level meters. Specification sheet 244 also includes evenly graduated electric flow meters.

British Hartford-Fairmont Limited, Rockware Avenue, Greenford, Middlesex, England, has made available a catalog reviewing the services of its company: technical, consultative, sales, engineering, and replacement facilities.

The catalog describes and provides illustration on the automatic batch charger, Corhart Electrocast refractories, the Hartford feeder, the Hartford feeder optional and variable equipment, feeder double gob process, valve timer, forming machines, machine conveyors, stackers, lehrs, and laboratory instruments.

The Foxboro Company, Foxboro, Mass., has issued a 16-page illustrated bulletin describing the restyled Foxboro circular case controller.

Showing typical applications, the bulletin discusses each unit of a pneumatic control system, from the measuring element to the control valve. A section of installation diagrams and text is devoted to on-off and proportional control, explaining how to select the appropriate controller action to match the demands of a process. Instrument components and their individual functions in the control of such equipment as storage type heaters, kilns, dryers, etc., are covered.

A two-page data section analyzes the four classes of measuring systems available for automatic temperature control, illustrating a variety of temperature bulbs, sockets, flanges, and other accessory equipment. Measuring elements for automatic pressure control are also shown.

Pemco Corporation, Glass Color Division, Baltimore 24, Maryland, has announced the distribution of its new brochure, "Glass Colors by Pemco."

Glassware for special uses, such as beverage bottles, laboratory flasks, light bulbs, etc., all call for specially developed vitrifiable colors. Matching coefficients of expansion are necessary so that the applied colors do not weaken the glass and resistance to alkalies, acids, or sulphides are essential in some instances.

To describe briefly these various classifications and the series of colors developed for each classification is the purpose of this new brochure. Under the headings Tumbler Colors, Bottle Colors, Dinnerware Colors, Cosmetic Containers, Lighting Unit Colors, Convexing Colors, and Special Colors, are listed the characteristics, firing temperatures, and available media in each group.

The Cambridge Wire Cloth Company, Cambridge, Maryland, has issued a new, revised catalog for its wire mesh conveyor belts.

Totaling approximately 140 pages, the new catalog gives data on uses for wire mesh belts, including photos and flow sheets, selection of belt specifications, conveyor design, belt drive mechanisms, and metallurgical tabular data.

The Harshaw Chemical Company, 1945 East 97th Street, Cleveland 6, Ohio, has issued a new folder featuring the new Harshaw crystal model kit.

This four-page folder illustrates and describes this new device which demonstrates crystal structure in three dimensions. Models constructed with the kit are essentially space lattice models which also show abstract schemes of repetition. Illustrated is a body centered cubic structure (110 cleavage) and a face centered cubic structure (111 cleavage). The model kit consists of 10 plastic plates, 4 supporting rods, 32 spacers, 50 black spheres, and 50 white spheres.

Hardinge Company, Incorporated, York, Pa., has issued a new 12-page catalog, Bulletin No. 18-B, describing its line of tube mills for grinding and pulverizing.

The catalog discusses the application, construction, and specifications for the Hardinge pebble tube mill and ball tube mills. It also illustrates several types of compartment mills.

NOW

A BETTER COMBINATION THAN EVER!

DRAKENFELD COLORS IN

IMPROVED

Drakotherm

Since the introduction of Drakotherm containing colors for screen process printing, continued research, coupled with extensive field experience by our technical staff, has resulted in important improvements in this thermo-plastic medium.

NOW Drakenfeld Colors in Drakotherm have all these advantages:

1. Availability in both high and low melting ranges.
2. Prints harden instantly to non-tacky surfaces when they touch the ware. No waiting for colors to dry or ware to cool.
3. Colors *stay* fluid by simplified resistance heating of the metal mesh stencil or by thermostatically-controlled radiant energy heaters.
4. Fire down smoothly.
5. Permit immediate subsequent color application cold, in regular squeegee oils.
6. Print razor sharp, with the finest detail, even to the smallest letters used on the back labels of packers' ware, cosmetic jars, and bottles. No smudging. No smearing.
7. Minimized screen clogging. Costly "time out" for washing practically eliminated.
8. Eliminate driers.
9. Ideal for automatic and semi-automatic equipment.
10. Reduce number of misprints.
11. Offer the designer greater latitude in creating new designs.
12. Permit printing attractive wrap-around designs on tumblers.

Drakotherm-containing colors have won wide acceptance since they were first introduced Get acquainted with the latest improvements. Special formulations are available for your particular needs. Learn how much those fast-printing colors can save in time and money for *you*. Phone, write for complete information.

DEPENDABLE SERVICE ON: Acid, Alkali and Sulphide Resistant Glass Colors and Enamels . . . Silver Paste . . . Crystal Ices . . . Squeegee and Printing Oils . . . Spraying and Banding Mediums . . . Glassmaker's Chemicals . . . Glass Decolorizers . . . Glass Frosting Compounds . . . Decorating Supplies

Drakenfeld

UR PARTNER IN SOLVING COLOR PROBLEMS

B. F. DRAKENFELD & CO., INC.

Executive Offices: **45-47 Park Place, New York 7, N.Y.**

Factory and Laboratories: **Washington, Pa.**

For "on the spot" assistance . . . call on our Pacific Coast Agents:

BRAUN CORPORATION
2260 East Fifteenth Street
LOS ANGELES 21, California
Phone: TRinity 6031

BRAUN-KNECHT-HEIMANN COMPANY
1400 Sixteenth Street
SAN FRANCISCO 19, California
Phone: HEmlock 1-8800

LEE W. MINTON RE-ELECTED GBBA PRESIDENT

Lee W. Minton was re-elected unanimously as President of the AFL Glass Bottle Blowers Association of the U. S. and Canada at the Union's recent 60th biennial convention. Vice President Raymond H. Dalton, Secretary Newton W. Black, and Treasurer Ellis Tibbles were also re-elected.

The convention showed membership at the highest peak in the Union's history with 45,500 members on the rolls. Twenty-three new locals have been chartered since the last convention in 1950 and 9,000 new members have been added. It was announced that the Union has organized 75% of all plants in the new fiber glass industry.

GUSTIN-BACON ESTABLISHES NEW SALES DIVISION

Gustin-Bacon Manufacturing Company has announced the recent appointment of George R. McMullen as Manager of its Kansas City Sales Division, with offices located in the Centennial Building. The new division will cover a four-state area, and concentrate on sales of the company's glass fiber insulation and industrial products.

Mr. McMullen has been associated with Gustin-Bacon since September 1952. Prior to that time, he had more than six years sales experience in the glass fiber industry.

It has also been announced that the Benjamin-Foster Company of Philadelphia has been appointed a distributor to handle the Ultralite and Ultrafine glass fiber insulations in its designated trade territory.

A. P. GREEN APPOINTS DISTRICT MANAGER

C. L. Petty, Jr., has been appointed District Sales Manager of the Philadelphia office of the A. P. Green Fire Brick Company.

Mr. Petty has been a member of the company's sales organization for over 15 years. Prior to his new assignment, he was District Sales Manager of the Milwaukee office.

CORNING ORGANIZATIONAL CHANGES

The appointment of J. A. Celaschi as Atlantic District Sales Manager headed a series of organization changes in the Consumer Products Division of Corning Glass Works, announced by Division Distributor Sales Manager J. M. Bredfeld.

Mr. Celaschi, who has been with Corning since 1933, was sales representative in the Cincinnati territory immediately prior to his new appointment. He replaces John Echternach, who has left the company.

In another Atlantic District change, Peter Herendeen, former sales representative in the Chicago area, has been appointed the new sales representative in the Atlanta territory, replacing R. O. Wheeler. In the Central District, William T. Dee, formerly sales representative in the Des Moines territory, has been transferred to Pittsburgh. Richard P. Callahan, representative in the Omaha area, will now handle both the Omaha and Des Moines territories.

• DESIGN
• ERECTION
• OPERATION

of Glass Plants

DOMESTIC AND FOREIGN

Complete Glass Plants and Equipment, Batch Systems, Glass Melting & Sodium-Silicate Furnaces, Batch Feeders, "Schmid" Mechanical Gob Feeders, "Liberty" Pneumatic Gob Feeders, Automatic Handling Equipment, Stackers, Lehrs, Machines, etc. for manufacture of containers, flat glass, pressed ware, and tubing. Furnace Repairs and Rebuilding. Process Engineers.

ARTHUR W. SCHMID COMPANY

ENGINEERS AND CONTRACTORS

INVESTMENT BUILDING, PITTSBURGH, PA.

Cable address: "Schmid" Pittsburgh
"Glasprint" New York

International Division: 444 Fourth Avenue
New York 16, N. Y.

How to handle

Hot Gases

Chemical Fumes

Erosive Dusts

the Morgan Ejector

. . . does it efficiently, and economically. Notice that the gases and fumes do not pass through the fan. Cold air shot through a Venturi tube creates a vacuum that draws the fumes, mixes them with the cold air and releases them to the atmosphere at reduced temperatures.

The Morgan Ejector is operating efficiently in many installations. It has proved that it can do a tremendous job at relatively low cost. Let us tell you more about it.

CCC-37

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

PITTSBURGH, PA., 2815 Koppers Bldg. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, England

TOLEDO UNIVERSITY NAMES GLASSMEN TO ADVISORY COMMITTEE

Dr. K. B. McAlpine of the Pittsburgh Plate Glass Company and J. A. Neubauer, Technical Director of the Columbia-Southern Chemical Corporation, have been named to membership on the Technical Advisory Committee of the Graduate Institute of Silicate Chemistry and Related Sciences at the University of Toledo.

Urban E. Bowes, of the administrative research department of Owens-Illinois Glass Company, has been elected Chairman of the committee, replacing the late David H. Goodwillie, former Executive Vice President of Libbey-Owens-Ford Glass Company.

CAMBRIDGE WIRE CLOTH EXPANDS IN THE SOUTH

The Cambridge Wire Cloth Company has opened a new southern sales territory with headquarters at 333 Candler Building, Atlanta, Georgia.

James M. Evans, formerly with Devoe Raynolds Paint Company, has joined the sales staff to handle both sales and service work in the new territory. The southern territory includes North and South Carolina, Georgia, Florida, Alabama, Mississippi, and parts of Tennessee.

L-O-F APPOINTMENTS

H. Ross Meriwether, an engineer who helped in the construction of the Shreveport factory of Libbey-Owens-Ford Glass Company, has been named General Superintendent of the glassmaking departments, according to John H. Goodwillie, Factory Manager.

Mr. Meriwether went to Shreveport in 1921 as assistant construction engineer for the U. S. Sheet & Window Glass Company, which built the plant and was predecessor to L-O-F. On completion of the plant, he moved into the engineering office and in 1940 was promoted to master mechanic. In 1946, he was made plant engineer.

Also announced was the appointment of Gill F. Walrath as the new Manager of Industrial Relations at the Thermopane factory of Libbey-Owens-Ford Glass Company at Rossford. Mr. Walrath joined the Rossford plant six years ago and since 1948 has been assistant personnel director.

BAILEY METER APPOINTMENTS

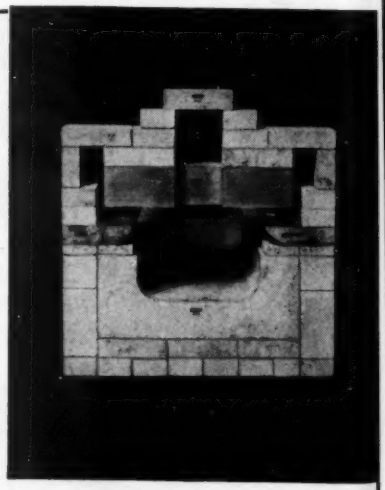
Announcement has been made of the appointment of A. L. Danielson as Manager of the Denver, Colorado, branch office of the Bailey Meter Company. Mr. Danielson is a graduate mechanical engineer of the University of Illinois.

Also announced was the appointment of G. M. Wallace as Assistant Sales Manager with headquarters in Cleveland. Mr. Wallace will supervise the sale of meters and control equipment in the process industries. Joining the company in 1940, Mr. Wallace became Manager of the Denver district in 1945. He is a graduate of Rensselaer Polytechnic Institute.

• Announcement has been made of the change of firm name of The British Hartford-Fairmont Syndicate Ltd. The word "Syndicate" has been dropped and the company now operates under the name of British Hartford-Fairmont Limited.

Cleaner Glass, Low Maintenance

with **CRYSTALITE Forehearths**



REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

★ Accuracy in formation to eliminate time-wasting adjustments.
★ High refractoriness and erosion resistance for longer life, fewer replacement shutdowns and cleaner glass.
★ Rigid control through each production phase for uniform quality and dimension accuracy.

Get Premium Performance Without Premium Price . . . by using REMMEY CRYSTALITE parts for your forehearth.

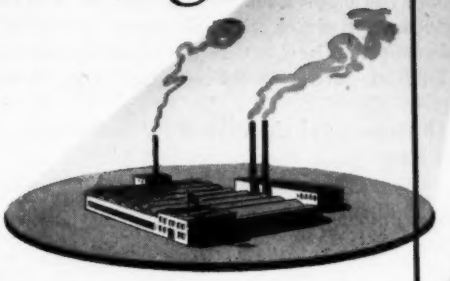
Dependable Refractories

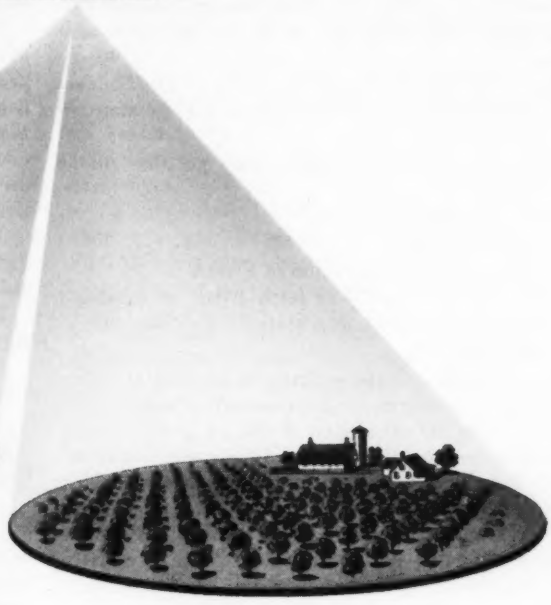
REMMEY

RICHARD C. REMMEY SON CO.
Philadelphia 37 • Pennsylvania

TRONA
INDUSTRIAL AND AGRICULTURAL CHEMICALS
ESTON CHEMICALS

New Light





TRONA-ESTON CHEMICALS INCLUDE:

TRONA† BRAND	THREE ELEPHANT BRAND*
Lithium Chemicals	Borax, Technical (coarse and fine granular-powdered)
Muriate of Potash (chemical and agricultural grades)	Boric Acid, Technical and U.S.P.
Sulphate of Potash	PYROBOR* Dehydrated
Potassium Pentaborate	Borax, Technical (coarse and fine granular)
Salt Cake	
Desiccated Sodium Sulphate	Pentahydrate Borax (refined)
Soda Ash	TRONABOR* Pentahydrate Borax (crude)
Sodium Pentaborate	

ESTON BRAND

ALKRON* (parathion formulations)	ESTONOX* (toxaphene formulations)
BROMOFUME* (soil fumigants)	Organic bromides
ESTOMITE* (residual type miticide)	TETRON* (Tetraethyl pyrophosphate formulations)
TUMBLEAF† (defoliants)	ESTONATE* (DDT dust concentrates and emulsifiable solutions)
TUMBLE-WEED† (herbicides)	

*Trade Mark Registered
†Trade Mark American Potash & Chemical Corp.

TRONA
INDUSTRIAL AND AGRICULTURAL CHEMICALS
ESTON CHEMICALS

ON OLD SUBJECTS...

Agriculture and Industry are as old as written history; old subjects, it is true, but through the years chemistry has altered established formulas and radically changed the accepted methods of both.

American Potash & Chemical Corporation has, since its earliest beginnings, supplied basic chemicals for both industry and agriculture. It now adds to these the Eston brand of fumigants, insecticides, herbicides, defoliants and refrigerants. Thus American Potash broadens its line of agricultural and industrial chemicals. It will continue to do so as other Trona, Three Elephant, and Eston brand products follow to meet customer requirements and market demands.

Keep an eye on American Potash.

PROVED CHEMICALS FOR INDUSTRY AND AGRICULTURE

American Potash & Chemical Corporation

Offices • 3030 West Sixth Street, Los Angeles 54, California
122 East 42nd Street, New York 17, N. Y.

• ESTON CHEMICALS DIVISION
3100 East 26th Street, Los Angeles 23, California

Plants • Trona and Los Angeles, California

(*Continued from page* 131)

$$k = A \exp(-W/kT) \quad (12)$$

and one finds

$$A_{300} = 3 \times 10^{-2} \quad (13)$$
$$A_{220} = 0.8$$

The lack of precision in W and f allows to consider these coefficients A as crudely identical and to conclude that the processes of disappearance of the two species are analogous.

In the following, an attempt is made to justify theoretically the order of magnitude found for the reaction rate.

Let N be the number of oxygen ions per cm³ in the sample
- n the F centers, of which
- x are dissociated
- E_f the energy of dissociation of F centers
- W the energy required to form a pair of separated vacancies, at the temperature in question, and
- X their number.

The study of the electroconductivity of silica at different temperatures informs of the existence of such vacancies and permits the calculation of (W/2) + U, U being the activation energy intervening in the more mobile vacancy; U can be calculated independently from diffusion experiments.

The following calculations give the number of F centers dissociated into one vacancy and one electron, and the mean time which the electron spends in the conduction band, following the book of Mott and Gurney (*"Electronic Processes in Ionic Crystals,"* 2nd ed. p. 142, p. 105).

Equilibrium of positive and negative vacancies:

$$X(X + x) / N^2 = \exp(-W/kT) \quad (14)$$

which for x much smaller than X becomes

$$X = N \exp(-W/2kT) \quad (15)$$

The relative smallness of x is proven by conductivity measurements on irradiated samples.

Equilibrium: F centers ⇄ negative vacancy + electron:

$$x(X + x) / (n - x) = (2\pi mkT/h^2)^{3/2} \exp(-E_f/kT) \quad (16)$$

For x « n, equations (15) and (16) give:

$$x = (n/N)(2\pi mkT/h^2)^{3/2} \exp[-(E_f - W/2)/kT] \quad (17)$$

At 500°K one obtains for SiO_2:

$$x = 10^{-3} n \exp[-(E_f - W/2)/kT] \quad (18)$$

It is probable that the fundamental process of F center destruction in silica is the recombination of one electron from a dissociated F center and one positive hole coming from a center absorbing in the 550 band. The fact that after the disappearance of B_{550} the weakening of B_{300} serves to produce C_{220}—i.e. V centers—strengthens this hypothesis.

If E_m is the thermal energy of dissociation of C_{550} and of N_{550}, the number of positive holes p must be of the form

$$p = v N_{550} \exp(-Em/kT) \quad (19)$$

v independent of T.

The thermal energy of the dissociation of a color center is generally about ½ of the energy corresponding to the wavelength of the absorbed light (Mott and G., loc. cit. p. 160).

The bond energy of the positive hole in the C_{550} center is then of the order of 1.2 e.V. The bond energy of a positive hole and one electron is at least 3 eV. Indeed 6 eV are required at least to optically excite an electron in non-irradiated silica (as the exciting photons have to have energy corresponding to a shorter wavelength than the transparency limit at 200 mμ).

Seitz, referring to F center formation, says[6]:
"Consider what will be produced when the electron approaches a vacancy pair; the calculation shows that the bond energy of the pair is 1 eV; on the other hand Mott gives 2 eV for the bond energy of one electron and one negative ion vacancy. Thus, the electron makes better use of the field of a negative ion vacancy than the positive vacancy does, and the F center forms."

Now one might think that the electron from a thermally dissociated F center will make better use of the positive hole contained in C_{550} than the rest of the 550 mμ center.

The calculation of the reaction rate for this hypothesis:

The number of electrons in the position to react is, as was seen:

$$x = 10^{-3} N_{300} \exp[-(E_f - W^1/2)/kT] \quad (20)$$

The number of positive holes in the position to react is:

$$p = N_{550} v \exp(-Em/kT) \quad (21)$$

v is a number near the fundamental frequency intervening in the theoretical expressions of specific heat, but slightly less, because of the perturbation brought into the lattice by the C_{550} (Mott and G., p. 136).

The value 10^{11} is taken for v here. Considering that the electrons are much more mobile than the hole (as the Hall effect evidences) one obtains

$$dx/dt = p.x.\sigma u \quad (22)$$

where u is the velocity or speed given by the equation

$$mu^2/ = 3kT/2 \quad (23)$$

and σ the capture cross-section of an electron for a positive hole. The study of photoconductivity in the alkali halides and in various semiconductors shows that σ is of the order of magnitude of 10^{-15} cm².

Since one F center always appears when an electron combines with a hole, one obtains

$$dN_{300}/dt = dx/dt = 10^{-3} v \sigma u N_{300} N_{550} \exp[-(E_f + E_m - W/2)/kT] \quad (24)$$

For 500°k and $u = 2.5 \times 10^7$ one obtains:

$$dN_{300}/dt = 2.5 N_{300} . N_{550} \exp[-(E_f + E_m - W/2)/kT] \quad (25)$$

Experimentally,

$$dN_{300}/dt = 3.10^{-2} N^2_{300} \exp(-W \text{ expt.}/kT) \quad (26)$$

with W expt. = 46 kc/mole

Discussion. If the theoretical expression is valid, the order of the reaction is no longer 2, since the number of centers absorbing near 500 mμ capable of giving positive holes seems larger than the number of the C_{300}. Experimentally one should find that the 2nd order law applied using a coefficient k calculated from the first measurements leads to a rate too weak for the end phase of bleaching. The measurements conducted to date do not permit a conclusion. It is sufficient, anyway, that N_{300} and N_{550} are of the same order of magnitude to make

the correspondence of theoretical and experimental reaction rates satisfactory. One has finally an interpretation of the experimental activation energy:

$$W \text{ expt.} = E_f + E_m - W/2 \qquad (27)$$

The Study of Crystalline Quartz

One could expect clearer facts yet in a crystalline lattice. One observes at 440 mμ a band analogous to the 550 mμ band in vitreous silica, but with the available quartz spectrophotometer, only the beginning of an absorption band was observable that might peak near 190 mμ.

Thermophosphorescence

The glasses and silica, crystalline or fused, have in common the property to emit light when one reheats them after pile or X-ray irradiation[1, 7].

Fused silica continues to emit light of a pale blue after the disappearance of B_{300} and B_{550}. This emission might be connected with the disappearance of C_{220} centers, or of centers in the farther uv. Other experimenters are studying this question thoroughly.[7]

BIBLIOGRAPHY

1. Choong Shin-Piaw, J. Phys. Rad. Fr., 1941, *2*, 41-45.
2. Johnson J. R., Briston R. H. and Blau H. H., J. Amer. Ceram. Soc., 1951, *34*, 6, 165-172.
3. Casler R., Pringsheim P. and Yuster P., J. Chem. Phys., U.S.A., 1950, *18*, 887-891 and 1564-1571.
4. Dutton D., Heller W. and Maurer R., Phys. Rev., U.S.A., 1951, *84*, 2, 363.
5. Melkonian E., Phys. Rev., U.S.A., 1949, *76*, 12, 1744-1749.
6. Seitz F., Rev. Mod. Phys., U.S.A., 1946, *18*, 3, 384-408.
7. Audubert R., Bonnemay M. and Lautout M., C. R. Acad. Sci. Fr., 1950, *230*, 20, 1771-1772.

S. R. SCHOLES' MANUSCRIPT ACCEPTED FOR PUBLICATION

The manuscript of a small book by Dr. Samuel R. Scholes, has been accepted for publication by Vocational Guidance Manuals, Inc., of New York. The book, "Careers in Ceramics," is expected to come off the press this Spring.

The book will be one of a number of manuals for the use of guidance teachers and others in advising young people in educational programs. It describes the various branches of ceramics and the types of employment to be found in the ceramic industries. Dr. Scholes also outlines the nature of the training required of a ceramist.

Dr. Scholes has published many technical papers and has written three other books, in addition to this latest one. These include: "Modern Glass Practice," "Glass Tank Furnaces," and "Handbook of the Glass Industry." Since 1937 he has written the annual paragraph on glass which appears in the Encyclopedia Britannica Book of the Year.

• Announcement has been made of a change in address of the Society of Glass Technology. The Society's new address is "Thornton," Hallam Gate Road, Sheffield 10, England.

• The election of Lloyd L. Austin, Los Angeles banker, as a Director of American Potash & Chemical Corporation has been announced. It has also been announced that George Mordy, Los Angeles accounting executive, has been elected a Director of the Trona Railway, a subsidiary of American Potash & Chemical Corporation.

In container ware batch
B_2O_3*
ANHYDROUS BORAX
ANHYDROUS RASORITE
BORAX—BORIC ACID
Speeds melting rate
Speeds fining rate
Improves durability . . . appearance
Container ware manufacturers are becoming increasingly aware of the merits of B_2O_3 as a minor constituent. A primary source of supply is the Pacific Coast Borax Co. with its continuous record of supplying highest quality boron compounds for more than fifty years. One single organization—from mine to refined product—assures top grade.
PACIFIC COAST BORAX CO.
DIVISION OF BORAX CONSOLIDATED LIMITED
MANUFACTURERS OF FAMOUS 20 MULE TEAM PACKAGE PRODUCTS
NEW YORK • CHICAGO • CLEVELAND • LOS ANGELES

LOOK, JOE!
THE ONLY FAST, ECONOMICAL WAY TO RELINE THAT FURNACE or BOILER is the "CLIPPER WAY"
ANY SPECIAL SHAPES . . .
Skews, Splits, Angles, Soaps
CUT IN SECONDS
WITH A
Dustless
Clipper
MASONRY SAW
CUT IN 24 SECONDS
CUT IN 12 SECONDS
CUT IN 17 SECONDS
CUT IN 19 SECONDS
CUT IN 11 SECONDS
CUT IN 13 SECONDS
CUT IN 7 SECONDS
15 MODELS PRICED FROM $265
MODEL HD
OUR ONLY BUSINESS FOR NEARLY 20 YEARS... MASONRY & CONCRETE SAWING
A CLIPPER MASONRY SAW WILL PAY FOR ITSELF FROM YOUR SAVINGS IN TIME AND MATERIAL!
Every shape and size refractory cut in seconds! Perfect fitting reline jobs that last longer — cost less. And Clipper's Patented features give you DUSTLESS cutting, instant Portability and complete flexibility.
It's YOURS on...
FREE TRIAL . . .
Discover how CLIPPER will increase profits by increasing production at reduced costs. "On the job" FREE TRIAL guarantees satisfaction at no obligation.
DEPEND on CLIPPER SUPERIOR BLADES
...all specifications of Abrasive, Diamond & "CBR" (Break-Resistant) Blades guaranteed to, "Consistently Provide the fastest cut...at the lowest cost...with the greatest ease!"
SAME DAY SERVICE FROM YOUR NEAREST FACTORY BRANCH —SEE BELOW
"4 OUT of 5" Concrete Saw Users Choose CLIPPER "CONSAWS"
For Sawing Repair Patches and Trenches in Floors, Runways and Streets
5 MODELS GAS or ELECTRIC POWERED
Clipper
NATION-WIDE DIRECT FACTORY SERVICE
MANUFACTURING CO.
• CINCINNATI • ATLANTA
• BOSTON • DETROIT
• WASHINGTON, D.C. • PITTSBURGH
• CHARLOTTE, N. C. • NEW YORK
• PHILADELPHIA • BIRMINGHAM, ALA.
• CLEVELAND • LOS ANGELES
• ST. LOUIS • INDIANAPOLIS
• CHICAGO • ST. PAUL
• HOUSTON • MILWAUKEE
• AUSTIN, TEXAS • DALLAS
• SAN FRANCISCO
IN CANADA P.O. BOX 476 WINDSOR ONTARIO
TEAR OUT AND MAIL !
CLIPPER MANUFACTURING CO.
2821 S. WARWICK • KANSAS CITY 8, MO.
Send FREE Literature and Prices on:
☐ CLIPPER MASONRY SAWS
☐ DUSTLESS MODELS
☐ DRY ONLY MODELS
☐ CLIPPER CONSAWS
☐ CLIPPER ABRASIVE BLADES
☐ WET ☐ DRY
☐ CLIPPER DIAMOND BLADES
No. 99 IND.
COMPANY
ADDRESS
CITY STATE

ELECTRICAL GLASS MELTING . . .

(*Continued from page* 137)

burn process has been changed over from the Souchon system to the Electroverre-Romont system of heating. The Colburn device was replaced by two Fourcault machines, and the tank corresponded in measurements and construction with that described in Fig. 13.

Suitability of Electric Tanks for Automatic Bottle Machines

The problem of adapting the electric tank to the requirements of automatic forming machines now arose for solution.

Two major groups are distinguished. In one of these, the machine is supplied with glass by an apparatus attached to the tank, which at regular intervals drops gobs of glass, one after another, into molds on the forming machine. This apparatus is called a "feeder." The other type of machine is called a self-feeding blowing machine. It draws its own gobs from the tank, by suction, into the parison molds. Either of these methods of feeding glass requires a burner, using oil or gas, in order to maintain the glass near the feeder at a uniform temperature. A patent issued to Manufacture des Glaces St.-Gobain[36] discloses an attempt to do this auxiliary heating by electricity, although thus far without apparent success. This auxiliary heating in feeder operation is still being done with oil or gas.

Some of the suction-fed automatic bottle-blowing machines require a so-called forehearth with a revolving pot. Globars have been tried for heating the chamber of the revolving pot. The designed capacities have been too small so that the rods were overheated and frequent breakages occurred. Fundamental reasons are the same as those already described for the electric furnaces of Brown and Boveri. The Swiss factories turned to small auxiliary burners, gas-fired.

Numerous bottle machines, self-feeding from the tank, require neither revolving pot nor feeder. The design of such a machine appears in Fig. 16. Here is found the best integration of electrical melting and mechanical bottle-making. The above-named glass factory, because of these considerations, has gone over to a machine system where glass is formed out of the tank, whereby the whole problem of heating the forehearth vanishes.

Fig. 16 shows a boot in the working chamber from which the parison mold, by suction, takes the gather of glass. This boot is essential with oil- or gas-firing, in order to maintain constant temperature at the gathering spot. It has been demonstrated in practice that with electrical heating this boot is unnecessary.

(*To Be Continued*)

COLUMBIA-SOUTHERN BECOMES FIFTH TO SUPPORT SILICATE CHEMISTRY INSTITUTE

The Columbia-Southern Chemical Corporation has become the fifth nationally-known firm to join in support of the Graduate Institute in Silicate Chemistry and Related Sciences at the University of Toledo, President Asa S. Knowles has announced. A pledge of $15,000 over a five-year period brings the total support of the Institute to $165,000.

NEW SKYLIGHT GLASS BLOCK

Pittsburgh Corning Corporation has announced its new Skytrol Glass Block. The new block is specially designed for use in skylights, both structurally and optically. This light-diffusing glass block is a 12" x 12" square, 4" thick.

The normally good insulating value of glass block has been increased by the addition of a fibrous glass screen sealed in the block, creating a double cavity. This screen not only gives a better insulating characteristic to the block ($U = 0.43$), but offers better daylighting control by diffusing the light. The screen, in addition to the skylight block's internal prisms and Soft-Lite Edge, assures evenly diffused daylight from a panel of uniform illumination.

FERRO APPOINTS ASSISTANT RESEARCH DIRECTOR

Robert W. Pelz has been appointed Assistant to the Director of Research of the Ferro Corporation, according to an announcement by O. O. Kenworthy, Director of Research.

Mr. Pelz was graduated from the University of Illinois with a B.S. in ceramic engineering in 1946, and took a Master's degree there in the same field the following year. Long active with Ferro's ceramic research projects, Mr. Pelz has lectured extensively before colleges and other groups on "The Story of Porcelain Enamel," a demonstration-talk originated by Dr. M. J. Bahnsen. He has also contributed to ceramic literature.

• The Spring session of the semi-annual X-ray Diffraction School will be held at the plant of North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, New York, during the latter part of April. Basic subjects to be covered include X-ray diffraction, new high and low temperatures camera techniques, fluorescence analysis, Geiger-counter X-ray spectrometer, and electron microscopy and electron diffraction.

Specify DU PONT COLORS

for

Distinction and Durability

in your glassware decorations

GLASS COLORS for every decorating need are available from Du Pont. Made under exacting scientific control and thoroughly pretested before shipment, these colors provide outstanding highlights for your labels and decorations . . . insure maximum durability under all service conditions . . . bring new economy to your decorating program. Here's why:

- **UNIFORMITY** *from shipment to shipment*
- **EASE OF APPLICATION** *in designs of all types*
- **STABILITY** *under firing*
- **MAXIMUM COVERAGE**
- **HIGH CHEMICAL RESISTANCE**

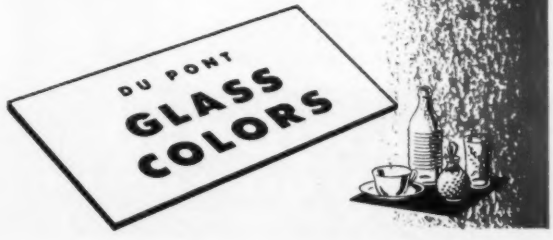
DU PONT TECHNICAL MEN will be happy to help you adapt these colors to your decorating needs. These men will bring a broad background of experience to bear on your individual problems . . . will offer specific recommendations on how you can increase production and cut cost by getting maximum efficiency from the material and equipment used in your process.

FOR MORE INFORMATION about Du Pont glass colors and assistance in your decorating program, contact your nearest Du Pont office or write to: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

DU PONT

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

DISTRICT AND SALES OFFICES: Baltimore • Boston • Chicago • Cincinnati • Detroit • El Monte • New York • Philadelphia • Pittsburgh • San Francisco

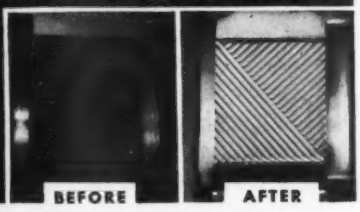


AMCO

Design, Erection and Operation of Manufacturing Plants and Furnaces for All Types of GLASS WARE

AMSLER MORTON CORPORATION
CHAMBER OF COMMERCE BUILDING, PITTSBURGH 19, PA.

Hydro-Finish leaves glass molds READY for USE!

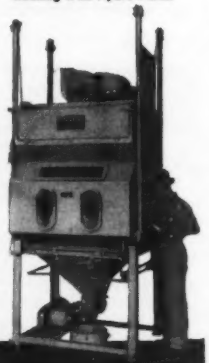


Complicated molds are easily cleaned and left *ready for use* with Pangborn Hydro-Finish! Hand cleaning and polishing is virtually eliminated! And you save additional time and labor because a Hydro-Finish machine, operated by one man, removes discoloration and scale in *minutes* instead of hours!

What's more, Hydro-Finish's use of fine-mesh abrasives suspended in liquid gives you a precision job. Sharp edges are maintained . . . tolerances are held to .0001 . . . molds last longer . . . precision equipment is protected.

Get complete facts on Hydro-Finish and how it can save *you* money! Write for Bulletin 1400-A to: PANGBORN CORP., 3400 Pangborn Blvd., Hagerstown, Md.

Actual untouched photos of mold before and after cleaning with Hydro-Finish



Pangborn
BLAST CLEANS CHEAPER
with the right equipment for every job

PROVIDING GLASS INFORMATION . . .

(*Continued from page* 143)

interested in what the other fellow does. Its factory doors and its production lines and processes are closed to visitors. Sure, you might be able to walk through the factory, but the superintendent has orders to act dumb when you get to the guts of the place, and he'll by-pass the best part of the plant when he can get away with it. That company exists in an ivory tower.

Then there is the other type of company. You can go anywhere and you can talk with anyone. If something new is being tried out, the competitors can find out just what is turning out well, and just where the new idea falls down. And similarly, the superintendent of that plant can visit the competitor and receive the same sort of treatment.

The point to remember is that competition between companies has ceased to be the problem of modern industry. Any management which believes there are trade secrets in his industry belongs to the gay nineties. Its thinking is archaic, and because its thinking is archaic, it is on the way out.

Competition today is between *industries*. And the better we can produce glass in competition with other materials, the stronger the industry, the stronger the components of that industry.

In that exchange of ideas, in that exchange of information of all kinds, in solidifying the resources of the industry and giving it a soul and purpose, the business press is the one, and the *only* one, vehicle for accomplishing this end.

We publishers in the glass industry want a better business press. The services we render you, despite the problems I have enumerated, can be made better services. But we can't make them better without your cooperation. We can't exchange ideas unless we are given the ideas to work with.

I've told you about the different types of papers serving business. One of these types stresses news, personal activities, statistical reports. That is the type of journal such as Jay Ebel's *American Glass Review*. From the picture I have painted to you of this industry, and now you see why I painted that picture, Jay could not possibly afford a complete staff of field representatives. So he depends upon the cooperation of you executives to furnish the leads he must have. Why not get your management to designate someone in your company as a public relations officer and help him. Your industry would benefit; you, individually, would benefit.

Some of the rest of us stress the technical and production side of glassmaking. We try to help production men, perhaps to understand some new process, perhaps some new raw material, perhaps a new method of batch control, perhaps a description of some plant that is turning out more glass and does it more economically. Tell us about it so we can tell others, and, in return, you'll receive what the others tell us.

In conclusion, may I thank your chairman for the privilege of appearing on your program. It has been a very enjoyable experience for me. Though I speak for all of our business press, my views necessarily are slanted by my own experience, my own perspective. Nonetheless, I have tried to see with their eyes, and hope in a measure I have succeeded.

RESULTS OF RAIL FREIGHT STUDY REPORTED

Rail freight shipments of fibre-cased glass products are a relatively claim-free cargo, ranking 17th in a list of 20 commodity groups studied over the past three years by a group representing the railroads and the Fibre Box Association. The group's final report, released last month, showed the average claim to be $2.

Further testimony to the safe transport of glassware comes from the fact that the commodity was dropped from the study after the initial year's work, while numerous other cargoes were checked for the full three years and yielded higher claims per freight car.

In relation to revenues, empty glassware and china (the two were bracketed for purposes of this study) produced claims amounting to 0.7 per cent of revenue. This contrasts with the 12.6 per cent claim-revenue ratio shown by canned fruit juices, the largest claim producer.

The survey was made as part of a campaign to reduce claims which totaled $135 million in 1948. As a result of the study, embracing only 3,440 carloads, the roads expect to broaden their educational and corrective programs, and to direct their efforts particularly toward those shippers with consistently high claim experience. The researchers also suggested that the Association of American Railroads create a department to study every carload of packaged goods, tallying sizes of claims and type of products shippers' and consignees' names and locations. No action on this recommendation has yet been taken, an AAR spokesman told THE GLASS INDUSTRY.

BALL BROTHERS APPOINTS SOUTHWESTERN MANAGER

John E. Bellinger, who has been associated with the glass container industry for 18 years, was named General Manager for the Ball Brothers Company Southwestern Division, with plant and headquarters in Okmulgee, Oklahoma.

Mr. Bellinger resigned a long association with the Anchor Hocking Glass Corporation and the sales managership of their general line containers to accept management responsibilities for Ball activities in the southwest. These responsibilities cover both commercial glass container and consumer product lines. In his new position, Mr. Bellinger will report to Duncan C. Menzies, Executive Vice President and General Manager.

L. J. HOUZE ELECTS ASSISTANT TREASURER

Armand L. Houze, Jr., has been elected Assistant Treasurer of the L. J. Houze Convex Glass Company, it has been announced by E. V. Ogg, Executive Vice President.

Mr. Houze, eldest son of the president of the firm, will continue to serve as glass technologist and as a member of the Board of Directors.

DR. E. STEIDLE OF PENN STATE TO RETIRE

Dr. Edward Steidle, Dean of the School of Mineral Industries at the Pennsylvania State College since 1928, will retire with emeritus rank on June 30. His retirement was announced by President Milton S. Eisenhower, who also revealed that Dr. Elburt F. Osborn, Associate Dean of the School, will succeed Dean Steidle.

KERR GLASS MARKS FIFTIETH YEAR

On February 19, Alexander H. Kerr & Co., Inc., celebrated its 50th anniversary. It was 50 years ago on that day that the Kerr Glass Manufacturing Company, makers of Kerr Mason jars and caps, was founded. Although the executive offices of the firm are now in Los Angeles, it was founded in Portland, Oregon, by the late Alexander H. Kerr.

After the death of the founder in 1925, his widow, Mrs. Ruth Kerr, took over as president of the company and successfully operated it through growth and expansion until it now includes plants in Santa Ana, California, Sand Springs, Oklahoma, and Huntington, West Virginia.

1952 ANNUAL REPORTS

Among the annual reports thus far received covering the activities during 1952 of glass companies and suppliers serving the glass industry is that of Owens-Illinois Glass Company whose net earnings for 1952 were $16,200,820.50, or $5.30 per share. This compared with earnings of $17,022,615.59, or $5.57 per share in 1951. Sales and other operating revenues amounting to $293,181,522.78 were 5.7 per cent below the 1951 total of $309,774,611.08.

Net sales of the Brockway Glass Company during 1952 were $18,378,633.80. This was an increase of $2,542,233.90 over the previous year's sales, which, according to the Annual Report, was basically due to the acquisition by Brockway of the Sterling Glass Company. Net profit at the end of the year amounted to $597,977.05.

Diamond Alkali Company reported net sales for the year of $76,673,311, as compared with $80,748,796 during 1951. Net income, after provisions for Federal Income and Excess Profits Taxes, was $5,461,820, equivalent to $2.18 per common share. This compared with 1951 net earnings of $6,674,297, or $2.95 per common share.

Net earnings of $14,907,893, equal to $2.88 a share, resulted from total sales of $16,442,764 in 1952, according to the Libbey-Owens-Ford Glass Company report. Sales were 5.5 per cent under the previous record year and earnings declined 3.7 per cent, largely due to the effects of the steel strike.

Hazel-Atlas Glass Company reported net sales of $70,911,083.36 for 1952 and net income for the year of $2,956,108.71.

The Carborundum Company and its U. S. and Canadian subsidiaries had sales of $70,173,250, with net income of $4,782,503, or $3.12 per share in the year ended December 31, 1952, compared with sales of $78,500,449 and net income of $6,461,426, or $4.23 per share for 1951. Sales volume during 1952, second highest in Carborundum's history, was 10.6 per cent lower than 1951, largely because of the prolonged steel strike.

MINNESOTA MINING FILES SUIT AGAINST STREETER MFG. COMPANY

Minnesota Mining and Manufacturing Company has filed suit against the Streeter Manufacturing Company of Reseda, California, for infringement of eight patents in connection with reflective sheeting.

The company's suit asks damages and an injunction against further infringement. It was filed in U. S. district court in Lost Angeles.

N.B.S. REPORTS . . .
(*Continued from page* 144)

of the punch cards containing spectra, bibliographic information and other useful data on 45 compounds are being made available to industrial and research laboratories.

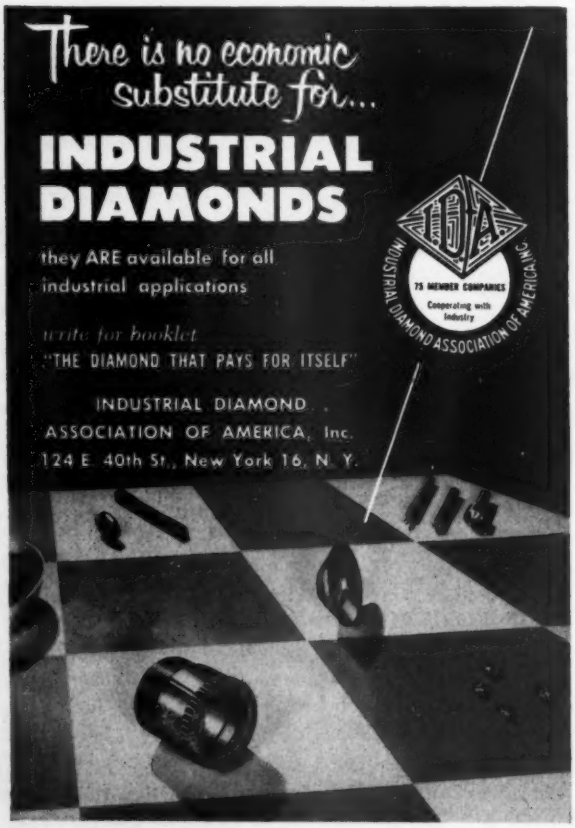
The study of the infrared absorption spectra of chemical compounds is today one of the most rapidly developing fields of chemistry. Not only are these spectra useful analytical tools, but they also provide important information on the molecular forces which determine chemical properties. As the available literature on the subject is already large and rapidly expanding, there has been a need for some means by which workers in the field could quickly gain access to the results obtained by others and thus avoid the time and expense involved in determining the data for themselves. Designed to meet this need, the infrared card catalogue provides a series of spectral curves with which the spectra of the unknown compounds can be compared, and makes data needed for theoretical computations readily available without the use of expensive sorting equipment. By means of these cards, the reported spectra of many compounds can be quickly found, the more important chemical linkage associated with a given spectral line can be determined, the work of any given author can be quickly assembled, and the properties of a compound which will aid in its identification can be located without loss of time.

The card catalogue is being compiled under the direction of E. C. Creitz of the NBS staff. Through the cooperation of Government and industrial laboratories, over 450 spectra are now on file at NBS, and others are being continually added. Bibliographical research by the Bureau staff has thus far produced between 8000 and 9000 literature references. The first group of cards being offered provide data on 28 organic acids, their methyl and ethyl esters, and a series of 17 ethers which involve these compounds.

The infrared data are presented on machine-size key-sort cards, which are supplied to users at cost The cards are edge-punched and notched so that they may be sorted by means of a knitting needle or an inexpensive sorting machine. For each compound in the catalogue, there is at least one compound card and a series of abstract cards if the compound has been mentioned in the literature on infrared spectroscopy.

The compound card can be sorted according to four classifications: wavelength, melting or boiling point, chemical function group and number of carbon atoms. In addition, this card carries on its two faces empirical and structural formulas, a description of the particular sample from which the data are taken, the infrared spectrum of the compound, a table of wavelengths of the absorption maxima and a complete bibliography on the compound.

For each of the references in the bibliography, there is an abstract card, which carries the title, authors, journal citation, abstract and references to *Chemical Abstracts* (and to *Physics Abstracts* and *British Abstracts*, if available). Each abstract card is correlated with the appropriate bibliographic item on the compound card by means of a reference number. The abstract cards can


There is no economic substitute for...
INDUSTRIAL DIAMONDS
they ARE available for all industrial applications
write for booklet
"THE DIAMOND THAT PAYS FOR ITSELF"
INDUSTRIAL DIAMOND ASSOCIATION OF AMERICA, Inc.
124 E. 40th St., New York 16, N. Y.
75 MEMBER COMPANIES
Cooperating with Industry
INDUSTRIAL DIAMOND ASSOCIATION OF AMERICA, INC.

MARIETTA concrete stave silos are erected with an "eye to the future." Additional silos can be added as needed to increase capacity. Materials delivery systems can be installed to customer's specifications. A wide capacity range permits the selection of the silo best suited to your individual needs. Will keep stored materials safe from air, fire, moisture, cut your handling costs, permit you to stockpile a greater supply of raw ingredients. Write for complete information.

THE MARIETTA CONCRETE CORP.
MARIETTA, OHIO

BRANCH OFFICES:
509 Fifth Avenue, New York 17, N.Y.
Pulaski Hwy. at Race Rd., Baltimore 21, Md.
805 Bessemer Bldg., Pittsburgh 22, Pa.

be sorted by reference number, year of publication, subject classification and apparatus classification.

In addition to the key-sort cards, the Bureau proposes to print the spectra and bibliographic data that appears on the compound card on 8½ x 11-inch paper. IBM cards will also be supplied for those who wish to use IBM sorting and filing systems.

Eventually the Bureau plans to supplement the regular series of spectra with a special series to be obtained at high resolution on specially purified compounds. Each compound card for this series will contain all the physical and chemical data that can be obtained on the particular compound, such as melting points, boiling points, refractive indices, visible and ultraviolet spectra and X-ray diffraction data.

Detailed instructions for ordering the infrared cards can be obtained from E. Carroll Creitz, National Bureau of Standards, Washington 25, D. C. Because of the difficulties in printing and storing split sets, the cards will be sold only on a subscription basis. The price of the data will be the same whether printed on standard letter-size paper or on keysort cards. It is estimated that the complete cost of the service to the subscriber, exclusive of sorting and filing equipment, will be between $200 and $250 during the first year of operation.

• John Batchelor, X-Ray Equipment Company, Salt Lake City, Utah, has been appointed as local representative for the Research and Control Instruments Division of North American Philips Company, Inc.

INVENTIONS AND INVENTORS . . .

(*Continued from page* 148)

the suspension is applied to the interior of the glass lamp envelope and, after drying, the envelope is baked at a temperature of approximately 400-600°C. to burn out the binder.

In tubes so treated, the coating particles adhere firmly to each other and to the glass wall and are not dislodged by movement of mercury across the coated surface nor by heating and reshaping of the tube. The treatment effects changes in the physical, chemical, and luminescent properties of the phosphor. For example, the powder is bulkier, and the spectral distribution is shifted somewhat.

The patent contains two claims and the following references were cited: 2,298,968, Roberts, et al., Oct. 13, 1942; 2,344,081, Claude, Mar. 14, 1944, and 2,488,733, McKeog et al., Nov. 22, 1949.

PILKINGTON ELECTS NEW DIRECTOR

Lewis J-B. Forbes, Vice President of Pilkington Glass Manufacturing Company Limited, has announced that R. S. Roberson, Works Manager, has been made a Director of the company.

Mr. Roberson, who was educated at Birmingham University, joined Pilkington Brothers Limited immediately after the war and was engaged in glassmaking operations in the main plant until moving to Canada in 1951 to become Works Manager of the new Pilkington Canadian window glass factory.

Use **Pennsalt Aqueous Hydrofluoric Acid**

for etching and polishing glass

Available in 60% and 70% commercial grades
In tank cars, 165, 450 and 900 pound steel drums
Shipped from:

Cornwells Heights, Pa.
Natrona, Pa.
Calvert City, Kentucky

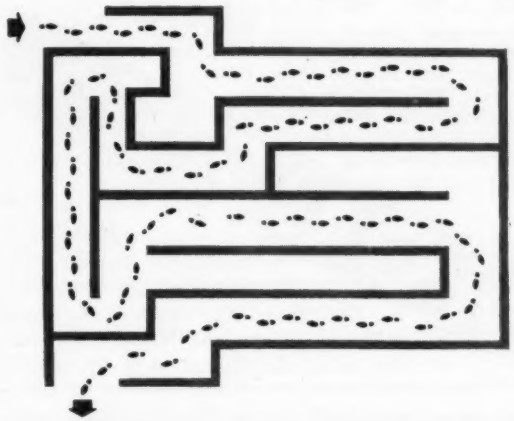
Save time by calling the nearest Pennsalt District Office

DISTRICT OFFICES AND TELEPHONES
Philadelphia 7, Pa.
Locust 4-4700

Appleton, Wis.—Appleton 3-9307
Berkeley 4, Calif.—Ashberry 3-2537
Chicago 1, Ill.—Andover 3-6170
Cincinnati 2, Ohio—Main 3168
Detroit 26, Mich.—Woodward 1-8051
Los Angeles 11, Calif.—Jefferson 6244
Paterson 1, N. J.—Lambert 5-3500
Pittsburgh 19, Pa.—Atlantic 1-5233
Portland, Ore.—Atwater 7655
Tacoma 1, Wash.—Main 9101

Pennsylvania Salt Manufacturing Company
265 Widener Building,
Philadelphia 7, Pa.

Pennsalt Chemicals



At every step, from mine to shipment, Gold Bond glasshouse lime and limestone products undergo intensive quality control. Only National Gypsum can supply *all* of these products—Gold Bond High Calcium Limestone, Gold Bond Dolomitic Limestone, Gold Bond Dolomitic Fluxing Lime, Gold Bond Dolomitic Hydrate and Gold Bond Low-Iron Calcium Carbonate.

Gold Bond INDUSTRIAL PRODUCTS

Ceramics Division

NATIONAL GYPSUM COMPANY

BUFFALO 2, NEW YORK

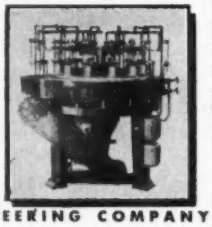
Kahle

Production speeds with
BUTTON STEM MACHINE
For sub-miniature tubes

Leading manufacturers of sub-miniature tubes were frantically re-vamping their old machines to avoid production tie-ups in making glass buttons with lead wires. These machines did not meet the exacting requirements of sub-miniature tube production.

Shown below is Kahle's new model 427 Button Stem Machine designed for T2, T3 and T2 x 3 sub-miniature button stems. This is a 12 head machine, with upper and lower moulds on every lead; dual-motor drive — indexing and head are driven by separate motors — indexing by barrel cam and rollers (hardened and ground) totally enclosed in oil. This machine can be made available for any stems, — with any number of heads, — with automatic feeds.

But this is the solution to only one of many problems which Kahle engineers have been asked to solve over the past 40 years. If you have any difficulty which can be overcome with custom-designed machinery, *write today and learn — without obligation — how Kahle's experience can benefit you.*



Kahle ENGINEERING COMPANY
1314 SEVENTH ST. NORTH BERGEN, N. J.

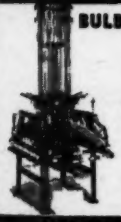
GLASS SPECIALTIES

Transparent Colored Blown Sheet Glass
Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY" — the scientific illuminating glass.

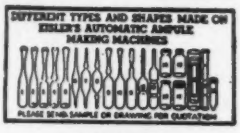
HOUZEX

L. J. HOUZE
CONVEX GLASS CO.
POINT MARION, PENNSYLVANIA
New York Office: 110 West 40th Street
Chicago Office: 1597 Merchandise Mart
"IF IT'S MADE OF GLASS, ASK US FIRST"

EISLER
Automatic Glass Machinery
For the Manufacture
of Incandescent Lamps and All Types of Electronic Tubes



BULB BLOWING MACHINES—AMPULE MACHINES
FORMS ALL TYPES AND SHAPES OF BULBS MADE FROM GLASS TUBING
VACUUM PUMPS
GLASS SLICING MACHINES
TORCHES—BURNERS


DIFFERENT TYPES AND SHAPES MADE ON EISLER'S AUTOMATIC AMPOULE MAKING MACHINES
PLEASE SEND SAMPLE OR DRAWING FOR QUOTATION

WE INVITE YOUR INQUIRIES

EISLER ENGINEERING CO., INC.
12 SOUTH 13TH STREET (near Avon Ave.) NEWARK 3, N. J., U.S.A.

RESEARCH DIGEST . . .
(*Continued from page* 149)

removal of which would require smaller amounts of energy and so give a higher vapor pressure.

This conclusion is in accordance with the results. A small increase in the fluorine content of the melt produces a transition from a glass quite clear on cooling to one developing a dense opal. This suggests that the precipitation of fluorides results from the presence of the easily removable fluorine, while the tightly bound fluorine is incapable of forming fluorides.

A.C.S. SECTIONS HOLD MEETINGS

New officers for the Central Ohio Section of the American Ceramic Society were elected at a recent dinner meeting. They are: *Chairman*, Frank N. McRitchie, Engineering Experiment Station at Ohio State University; *Vice Chairman*, John W. Lennon, Battelle Memorial Institute; *Secretary-Treasurer*, Clair R. Oberst, Industrial Ceramic Products, Inc.

The Philadelphia Section recently inaugurated its first "Ladies Night." There were orchids for the ladies and dinner music and entertainment. The March 17 meeting will be the Annual Penn State Night.

• Erwin P. Stupp, President of Stupp Bros. Bridge and Iron Company, has been elected to the Board of Directors of Laclede-Christy Company. Mr. Stupp is also a director of the Laclede Gas Company, Wabash Railroad System, and the American Institute of Steel Construction.

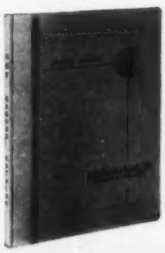
DELOS M. PALMER & ASSOCIATES
Consulting Engineers
Reg. Mechanical, Electrical & Industrial

•

Designers of
Special Purpose Machinery
For The Glass Industry

•

4401 JACKMAN ROAD TOLEDO 12, OHIO
Telephone: Kingswood 9611



free! NEW AGF BURNER CATALOG

The first complete catalog of never-before-available technical data.

Gives hole sizes, flame patterns, gas consumption on various gases and complete information with illustrations of—

Burners
Blow Pipes
Glass Fires
Mixers
Inserts
Ball Joints
Manifolds
Crossfires
Machlet Tips
Governors
Tunnels
Oxygen — Gas Burners

AGF
AMERICAN GAS FURNACE CO

Write for your copy today on your company letterhead.

134 SPRING ST., ELIZABETH 4, N. J.

CLASSIFIED ADVERTISEMENTS

WANTED

Need for production: Simpson Mixer, Raymond Mill, one or two Vibrating Screens. Please give full particulars. P. O. Box 1351, Church Street Station, New York 8, New York.

L-O-F EXPANSION

Further expansion and development of manufacturing facilities for Electrapane, the Libbey-Owens-Ford Glass Company's glass that carries an electric current by means of a transparent metal coating, has been announced.

George P. MacNichol, III, who has been in charge of scheduling at the Thermopane plant, has been named operating supervisor of the Electrapane production. Due to complexity of manufacture, development of special machinery, and sales clearance of the electric current-carrying glass as a defense product, it was announced that the operations would be segregated in a separate building adjoining the laminating plant and put under special supervision.

• A new laboratory, providing complete facilities for testing and developing materials, equipment, and processes, has been opened at the F. J. Stokes Machine Company, Philadelphia, Pa. The new facilities occupy about 2800 sq. ft. of floor space and represent an investment of more than $150,000.

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

NATIONAL AIROIL are SPECIALISTS in COMBUSTION EFFICIENCY

- Steam Atomizing Oil Burners
- Mechanical Atomizing Oil Burners
- Low Air Pressure Oil Burners
- Rotary Oil Burners
- Industrial Gas Burners
- Combination Gas and Oil Burners
- Tandem Block Combustion Units
- Fuel Oil Pump Sets
- Refractory Burner and Muffle Blocks
- Valves, Strainers, Furnace Windows

Detailed information gladly sent upon request

NATIONAL AIROIL BURNER CO., INC.

1255 East Sedgley Avenue, Philadelphia 34, Pa.

GLASS TECHNOLOGIST CERAMIST

Immediate openings available at General Electric's Cathode Ray Tube Plants at

SYRACUSE, NEW YORK
BUFFALO, NEW YORK
OWENSBORO, KENTUCKY

in

DESIGN ENGINEERING
FACTORY ENGINEERING

Opportunities for resourceful engineers to investigate and perfect diversified techniques and methods for glass to glass and glass to metal sealing . . . improve all phases of glass processing on monochrome and tri-color tubes. Laboratories well equipped and air conditioned... modern manufacturing facilities and practices.

College graduates preferred. Send resume to:

Technical Personnel, Department CR-112

GENERAL ELECTRIC

Electronics Park Syracuse, N. Y.

ENGINEERS
To The Glass Industry

Container Plants • Tableware Plants
Bulb and Tube Plants • Flat Glass Plants
Batch Systems • Fuel Systems
Furnaces • Lehrs • Feeders
and other special production equipment.

FORTER-TEICHMANN Company

Clark Building
Cable "Forter"
Pittsburgh, Pa.
Phone EXpress 1-0820
Incorporated 1936

PRECISION GLASS CUTTING
for the
LAMP AND ELECTRONIC TUBE INDUSTRIES

The Engineering Glass Laboratory Inc. is completely equipped for cutting all types of glass tubing to very close tolerance specifications.

Our many years of experience and "know how" in servicing many of the leading companies is your assurance of receiving top quality workmanship.

Our Engineers will be glad to consult with you on any of your glass cutting problems.

ENGINEERING GLASS LABORATORY, INC.
418 Central Ave., Newark 7, N. J. MArket 3-2113